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# Place of Science in the Human Knowledge

Dmitrii Kouznetsov<sup>1\*</sup>

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## ABSTRACT

The simple model for the classification of knowledge is suggested. The four types of knowledge are considered: customs, arts, religions and sciences. The strict definition of science is suggested to distinguish it from other kinds of knowledge and from pseudo-science. The model indicates the methodology of the scientific research that is aimed to avoid conflicts between science and other kinds of knowledge. This approach is suggested to exclude some concepts from the scientific knowledge by some formal criteria at very beginning of the consideration.

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## 1. PREFACE

This research is motivated by huge amount of fake results. Many of them pretend to be scientific. Especially grave the frauds are in Russia, due to the total corruption [1]. An example [2,3,4] of a fraud is presented in Fig. 1.



**Fig.1.** Idea of propulsion of satellite "Yubileiny" [2]; "Gravitsapa" [3]; leaders of the Russian cosmic program: D.Rogozin, V.Menshikov, V.Nesterov, A.Seliverstov, A.Varochko [7].

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<sup>1</sup>Institute for Laser Science, University of Electro-Communications, 1-5-1 Chofugaoka, Chofushi, Tokyo, 182-8585, Japan.

\*Corresponding author: E-mail: dmitriikouznetsov@gmail.com;

Figure 1 shows the main idea of self-propulsion [2] of the satellite "Yubileiny", the only available image [3] of inertoid "Gravitsapa", installed there, and leaders of the Russian cosmic program. They pretend, that the "gravitsapa" provides the support-less force and changes the orbit of the satellite (breaking the fundamental laws of Physics) [4,5,6].

Bulletin [8] collects warnings about the danger trends in the development of the Russian science in century 21. Many cases of the abuse are indicated.

The abilities of pseudo-scientists to publish fakes greatly exceed the abilities of enthusiasts to analyze and to criticize them. Then, the budget used for the money laundering, leaving no support for the scientific research. We need formal criteria to identify pseudo-scientific results. Such criteria (TORI Axioms) are main topic of this article.

Since year 2010, the Russian version of this article [9] provides the definition of science, that allows to qualify some results as non-scientific by the formal criteria, at very beginning of the consideration. That definition follows from the simple exercise [10], which, in its turn, is based on the ideas of refutability of scientific concepts; these ideas had been developed by Karl Popper [12, 13, 14] in century 20.

Phenomena similar to science (pseudoscience) occur not only in Russia. This motivated me to make the short English version, describing use of the TORI Axioms [11]; it appeared in 2013. Then, in year 2020, editor Ruma Bag asked me to extend it for book "New Insights into Physical Science". I suggest this extension here.

## 2. ABOUT TRUTH

Often, it is supposed, that a scientific result is true, correct; while any pseudo-scientific result is false, wrong, non-correct. Then, for the qualification of any concept, it is sufficient to check it, to verify it, and, if it is wrong, to reject it. Such a common sense looks reasonable. Unfortunately, the abilities of pseudo-scientists to publish wrong, mistaken, fake papers and get foundation for pseudo-science greatly exceed abilities of scientists to criticize them, to reveal errors and to indicate, that some results are wrong.

In this paper, another approach is suggested. The idea is not to criticize each wrong concept, but to suggest the narrow definition of term "Science" in such a way, that any concept can be qualified as "scientific" or "non-scientific", whenever this concept is correct or wrong. This cannot substitute the common sense, mentioned above, but gives the formal criteria, that allow to reduce the amount of results, that deserve a serious consideration.

Many Russian colleagues at school had to accept the strange concepts:

1. *Our Universe is infinite both in space and in time.*
2. *For photosynthesis, the green leaves use the central part of the visible spectrum of solar light.*
3. *The gradual evolution of a species with genotype of 48 chromosomes (monkey) led to the new specie with genotype of 46 chromosomes (mankind).*
4. *The communism in the USSR will occur within 20 years [15,16]*

Such concepts were suggested at the Soviet schools as a "scientific truths". However, they are not truths, nor even scientific. At least, they do not fit the definition of science, suggested in section 8.

The Soviet veterans still declare the postulates of Sovietism (that, are I think, just wrong) as a truths, as scientific facts. The attempts to understand, what happened in century 20, why the communism was not built-up, why the USSR collapsed, why corruption become the main phenomenon that

characterizes the entire life of the officials, why Russia is selling off the natural resources, etc. - are declared as 'pseudoscience' and 'false history' [17, 18].

The list of popular wrong concepts could be much longer. Many of them can be qualified as Sovietism. They appear as a religion, although the Soviet teachers had considered them as scientific facts.

The goal of this article is systematization, classification of the knowledge in such a way, that many pseudo-scientific concepts can be disqualified at once. The formalism had constructed for Physics (for needs of the Quantum Optics and the Laser Science), but it applies also to other sciences.

In this work, the simple model of classification of the human knowledge is suggested. The model includes only four categories: customs, arts, religions and sciences. The narrow definition of science had been suggested in 2010-2013 [9, 10, 11]; here I retell and extend the description.

Religions [19] are important kind of knowledge, and they should be distinguished from sciences. So, this article deals with both sciences and religions. I show, that absolute truth is attribute of a religion, but not a property of a scientific concept, even if the concept is widely accepted as a "scientific fact" [20].

Often, a scientific fact may be considered as a "true" – until some new, modern theory provides more efficient or more general concept for the same phenomena. Here are examples:

Prior to the heliocentric system of the universe, Ptolemy's geocentric system is a scientific fact.

Prior to experiments with nuclear reactions, the concept of conserving the number of atoms of each kind (in a closed system) is a scientific fact.

Before quantum mechanics, the fundamental possibility of describing any system in terms of the coordinates and velocities of its components is a scientific fact.

Many scientific facts, that remained during centuries, are already refuted. In such a way, the "truth" cannot be main criterion for the scientific knowledge. Other criteria are necessary.

### 3. OBJECTIVITY AND KARL POPPER

Objectivity is often considered as a "**cornerstone of science**" [21].

**"I frame no hypothesis"**, Isaac Newton wrote [22].

Teplov Boris Mikhailovich believes, that the objective method is essence of science [23]: **"..Objective truth is that part of our knowledge which correctly reflects reality and does not depend upon the subject, i.e. on human consciousness and will. Objective method, therefore, means the method that leads to knowledge of objective truth. For materialism, 'the recognition of objective truth is fundamental'; consequently all materialist science must be objective in method."**

Actually, the words about "objectivity" of science do not help to distinguish the true scientific results from the fake ones. The criterion of "objectivity" is used as a pretext for the physical extermination of opponents. In century 20, the repressions are especially grave in the USSR: **"The revolution cannot be made in white gloves"** [24]. This sentence justifies any crimes, if they serve the Great Idea.

During the USSR, of order of half of population of the country had been exterminated by the agents of KGB and other bolsheviks, claiming the struggle against the wrong concepts, for the "objectivity". In particular, the soviet fascists use this idea to murder the scientists. Practically, the idea of "objectivism" used to struggle against science and against scientists [25, 26]. Researches, who worked with theory of relativity, with quantum mechanics, with cybernetics were suppressed in the

USSR. Genetics had been exterminated. The psychiatry had been converted to the instrument of political repressions, for jailing and murdering of any citizen who does not accept postulates of Sovietism. The "objectivism", by itself, happens to be very subjective criterion: the concepts, supported by the officials, by the usurper, are declared to be "objective"; any doubts are declared as subjective "pseudoscience". In such a way, the idea of objectivity of science leads to destruction of science.

In century 20, Karl Popper extracts, discovers and describes the new, extremely efficient and useful kind of human knowledge [12, 13, 14]. He called it "science", although the term "science" was used before in a little bit different meaning; that meaning included the claim of objectivity. K. Popper declares, that the main property, that makes the research, the result, the concept "scientific" is not its objectivity, but the principal possibility to criticize and to reject, refute ("falsify") the concept [12]:

1. *It is easy to obtain confirmations, or verifications, for nearly every theory - if we look for confirmations.*
2. *Confirmations should count only if they are the result of risky predictions; that is to say, if, unenlightened by the theory in question, we should have expected an event which was incompatible with the theory - an event which would have refuted the theory.*
3. *Every "good" scientific theory is a prohibition: it forbids certain things to happen. The more a theory forbids, the better it is.*
4. *A theory which is not refutable by any conceivable event is non-scientific. Irrefutability is not a virtue of a theory (as people often think) but a vice.*
5. *Every genuine test of a theory is an attempt to falsify it, or to refute it. Testability is falsifiability; but there are degrees of testability: some theories are more testable, more exposed to refutation, than others; they take, as it were, greater risks.*
6. *Confirming evidence should not count except when it is the result of a genuine test of the theory; and this means that it can be presented as a serious but unsuccessful attempt to falsify the theory. (I now speak in such cases of "corroborating evidence".)*
7. *Some genuinely testable theories, when found to be false, are still upheld by their admirers - for example by introducing ad hoc some auxiliary assumption, or by reinterpreting the theory ad hoc in such a way that it escapes refutation. Such a procedure is always possible, but it rescues the theory from refutation only at the price of destroying, or at least lowering, its scientific status.*

Ideas by Popper are not widely accepted by colleagues; the believe in some "objectivity" remains [27]. The researchers suggest some non-refutable concepts in hope, that they do namely science, but not a religion: *"Why should I care about refutation of my results? I know, that they are true. They are irrefutable! If some reviewers have any doubts, let them search for a ways to refute them!"*

Such a hope, such a believe is used for fakes, destroying the science. It becomes impossible to understand, does the researcher believe in his/her own idea, or the case is an intentional fraud. One example of such a fraud is mentioned in the Preface. There are many such cases [28, 29].

Qualification of a research as "science" or "religion" depends on definition of science and on definition of religion. This indicates the need to elaborate the appropriate definitions, they are provided below in the special sections. The human knowledge is classified a way, that does not allow science to deal with non-refutable concepts.

This question is not only terminological. Many authors pretend, that their results are true; so true, they do not need to allow any refutation (sometimes, the term falsification is used in the similar meaning). This leads to the growth of various pseudosciences, which may be extremely efficient in obtaining funding, but useless in any other application.

The problem of classification of knowledge remains: neither "true", nor "objectivity" serve as main criteria for scientific knowledge. However, the ideas by Karl Popper indicate the way to classify the knowledge. Such a classification is suggested in the following four sections; they describe customs, religions, arts and sciences.

#### 4. CUSTOMS

Category of customs includes the commonly accepted behavior of humans. Also, it includes the habitual semantics of commonly used human languages.

Even the habit to drink from the bottle, shown in Fig.2, should be considered as knowledge and even skill; especially, if all the alcohol goes to the throat and no one drop is missed.

In the similar way, the money laundering with pretext of pray for reparation of roads, rockets or dams should be considered as a custom.

The genre of the last 3 pictures in Fig. 2 can be interpreted also as a religion (considered below) – under conditions, that the popes, performing the magic, believe, that their actions may repair the faulty rocket, or stop the flood, or, at least, reduce amount of puddles and clay on the road.

The meanings of words, even in a religion, are customs. At least part of semantics appears as a custom. Habits to use science, technology, ritual dress or magic are customs.

The usual meaning of the Bible is a custom, widely accepted in the Christian community. The sentence *“You shall love your neighbor as yourself”* allows various interpretations [31, 32], dependently on the meanings of the word “love” and its Hebrew and Aramaic equivalents. Some interpretations are not popular, they are not customs.

The interpretations of the New Testament by Tim Rice [33] and that Michael Bulgakov [34], due to the wide spreading, can be qualified not only as an art, but also as a custom, at least in certain literature or musical communities. Such an interpretation should be qualified a knowledge. In such a way, the meaning of words appear as a knowledge.

The folklore also falls in the category of custom. It is any knowledge, that is difficult to investigate by systematic methods. Any legend, story, narration leaves from category folklore, from category custom and becomes art or even science (history), as soon as it is written, published, criticized and considered in a scientific way as a possible historic evidence.

The semantics of the human languages and their understanding, the meaning of words is important part of a language. Customs, as kind of knowledge, give sense to other kinds of knowledge, considered below.



**Fig. 2. Customs [30]: drinking from the neck of bottle; use of magic for roads, missiles, dams.**

## 5. ARTS

Few examples of objects I consider as art [15] are shown in Fig. 3. In order to be more specific, I suggest the definition below:

**Art is any kind of knowledge that is free from internal rules and is realized in a reproducible form that allow its systematic investigation:** Such a definition corresponds to a goal formulated in the introduction, although it slightly reduces the set of things which could be called *art*. Usually a product of art has the following properties:

**A1.** Beauty: Here, the beauty is the extensive ability of any unexpected use. The prehistoric hunter, painting and observing an image of an animal on a rock, may guess how to catch this animal; the reader, laughing on a comedy, may ask himself: *Either I am free from all the evils shown?* - although the primary goal could be just laugh.

**A2.** Absence of structure: Intents to bring into the arts rules are not efficient. The arts use all other knowledges; the same product may have both artistic and scientific value.

**A3.** Wisdom: A painter, a writer, any artists with their works say more, than they planned to say, and more, than they understand by themselves. In this sense, the product of art may be wiser than the author.

**A4.** Entirety: Attempts to correct, to improve a product of art destroy it.

**A5:** Amoralism: Creatures that have goal to bring some moral to the society, have low artistic value if at all; the creature may violate any taboo of the society. Including the religious ones.

There exist very few examples of a product of art, created with goal to bring some certain moral to readers, that achieve this goal. Perhaps, of such a kind, there are "King Matt the First" by Janusz Korczak  
"Le Petit Prince" by Antoine de Saint-Exupéry.

In most of cases, the stronger the artist tries to bring some moral to consumers of his/her art, the farther from art is the product. The Soviet artists were highly motivated for bringing so-called "communistic moral" to the society. In the most of cases, instead of art, they were making propaganda, id est, misinformation. In the result, the population of the big country had been converted to criminals, alcoholics, drug-dependent barbarians with mafia of corrupted officials at the top.

There are special sciences about the art. Some references are collected in the special article

<https://mizugadro.mydns.jp/t/index.php/Art>

The art may affect humans through various senses. The object, performance or any other information can be qualified as "art", if it affects on emotions and behavior of a human. There is no formal ("objective") criterion, what is art and what is not art. Attempts to introduce such a criteria lead to censorship and suppression of art.

There are many sciences about art. Aiming the specific application of the classification, the topics of customs and arts are presented here only declaratively.



Fig. 3. Arts: Five examples of works by various artists [35]



## 6. RELIGIONS

Religion is kind of the human knowledge based on some (specific for each religion) set of irrefutable concepts, believes, texts, symbols and performances.

Usually, any religion is characterized with the most of following:

- R1.** The existence of at least one God is presumed.
- R2.** There exist canonical sacred text, that allow the humans to guess the will of God(s) and follow it.
- R3.** God like some actions of human, these actions are called Good.
- R4.** God dislike some actions of human, these actions are called Evil.
- R5.** The suggested set of concepts pretends to play an organizing role in the society: The following to namely this religion provides abilities for the kindness, prudence and wisdom significantly wider, than any other religions.

In this article, God is generic term denoting any intelligent subject that in some way (that is not available for humans) has abilities that greatly exceed those of a human. Actions related to these abilities are called miracles, marvels.

God may look like a human (Jesus Christ, Buddha, Lenin), but also can be "non-material" (God - Holy Spirit, World Revolution, Marxism). God may be omnipotent (almighty), invincible, immortal and predicts future:

*The Marxist doctrine is omnipotent because it is true [37].*

*Long live invincible marxism-leninism-mao tsetung tonight [38].*

*Lenin lived, Lenin lives, and Lenin will live [39].*

*The generation of those who are now fifteen will see a communist society, and will itself build this society [15].*

*The immortal beacon of Comrade Stalin will forever illuminate the path on which the Chinese people march forward [40].*

*And he said unto Abram, Know of a surety that thy seed shall be a stranger in a land that is not theirs, and shall afflict them four hundred years [41].*

Some religions do not identify themselves as religions, pretending to be sciences [42, 43].

The adepts consider their own belief as the only true concept, deny the dogmatic character of their believes [44] and treat any deviant behavior as crime, heresy and mental illness; the wrong-believers are punished or undergo the forced medical treatment [26].

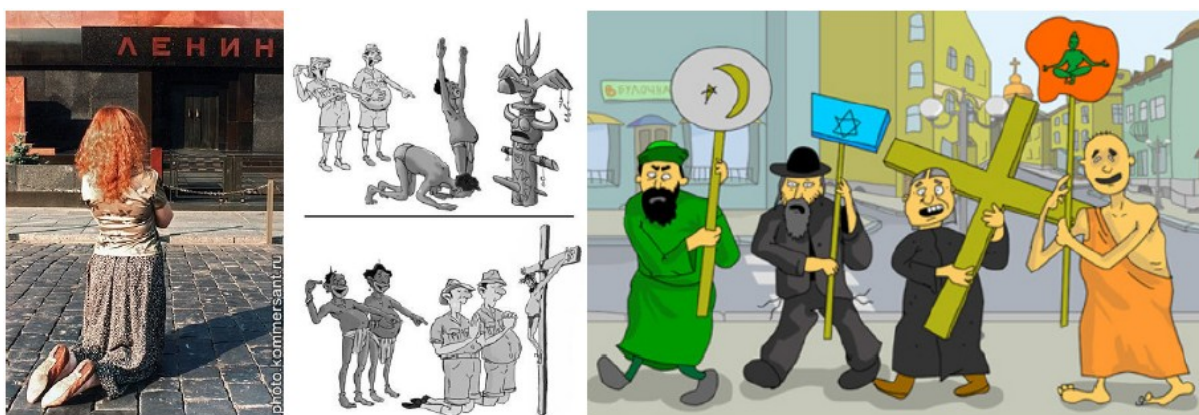


Fig. 4. Religions: Illustrations by S. Tihomirov [52], V. Shmakov [53], O. Kuvaev [54]

Some religions justify lies (misinformation, propaganda), sacrifices, betrays, massacre, murdering and wars, if they serve the needs of God: You cannot make revolution in white gloves [24, 45].

Most of religions avoid any refutable concepts. The concept is called refutable, if (and only if) in terms of this concept, some specific observation can be described, that negates the concept. Statement **“The Current Generation of Soviet People Will Live Under Communism”** [16] is refutable: based on such a declaration, the next generations (say, since year 1980) may shame, judge, punish, execute the Soviet veterans as liars and impostors. (This is an addition to the punishment for the war crimes, committed by bolsheviks since the beginning of the USSR; Sovietism approves and defends any crimes of the Soviet fuhrers with concept **“You cannot make revolution in white gloves”**; such a concept justifies any kind of genocide, even if 90% of population of a country are killed with such a slogan [45].)

Within few generations since creation of a new religion, it abandons, forgets its refutable concepts and becomes more stable. Here are the examples of irrefutable concepts:

**God bless America.** [46]

**Imperialism is evil.** [47]

**God gives the immortal soul to everyone.** [48]

**The righteous will be at Heaven.** [49]

**Socialism and communism are the future of Humanity.** [50]

However, the last statement (about communism) becomes refutable (and wrong) as soon as the year (1980) and the country (USSR) of realization of such a project are specified [16].

The canonical texts describes the marvels, miracles, magic, specific for each religion. The miracle may refer to the magic conversion of water into wine, to the drastic increase of the efficiency of the production by the inspiration of the Führer, catching of the spies by children, destruction of an army of the enemy tanks by several heroic soldiers launching grenades, etc..

A honest and effective pray can also be considered magic - if it leads to the desired result. Otherwise (for example, if after an expensive religious ritual, consecration, a space rocket fails, see Fig. 2), the pray should be qualified as fraud and money laundering. Such a fraud is rather custom, than a religion.

Not all religions pretend to be “the only truth”. So-called “civil religions” recognize themselves as only parts of the human knowledge [51]. Such a recognition makes the civil religions efficient in stabilization of a society on the civilized development, favoring prudence, technology and science.

Religions form significant part of the human knowledge and play important role in the human history. While a religion is tolerant with respect to other kinds of knowledge (and in particular, to other religions), it may assist the prosperity of the society.

No one religion can substitute other kinds of knowledge, nor even other religions, as one specific science cannot substitute all other sciences. Any society, where one religion dominates in an aggressive way, becomes barbarian compared to other countries within few generations; the people of such a society lose the ability to analyze the information.

Religions go through the all history of Humanity. There are no examples of stable atheistic societies. Even if the goal of creation of an atheistic country is declared – soon, within few years, the new, and very barbarian religion appears, pretending to be science, but also claiming to be “the only true knowledge”. (So it happens in the USSR, in China and some other “socialistic”, “communistic” tyrannies in century 20.) In order to consider this claim, term “science” should be defined. This is matter of the next section.



## 7. SCIENCES

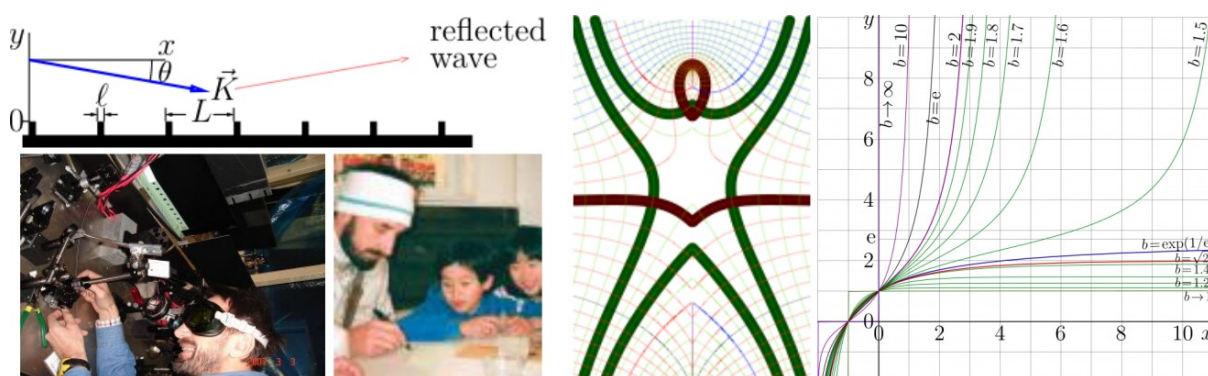
As it was mentioned in the second section, the term "science" may have different meanings. Following K. Popper, in this article, this term applies only to a refutable knowledge. In order to distinguish science at the background of pseudoscience and religion, the term *science* should be defined as follows:

**Science is kind of knowledge, activity and notations, based on concepts that have all the six properties below:**

- S1. Applicability:** Each concept has the limited range of validity, distinguishable from the empty set.
- S2. Verifiability:** In the terms of the already accepted concepts, some specific experiment with some specific result, that confirms the concept, can be described.
- S3. Refutability:** In the terms of the concept, some specific experiment with some specific result, that negates the concept, can be described.
- S4. Self-consistency:** No internal contradictions of the concept are known.
- S5. Principle of correspondence:** If the range of validity of a new concept intersects the range of validity of another already accepted concept, then, the new concept either reproduces the results of the old concept, or indicates the way to refute it. (For example, the estimate of the range of validity of the old concept may be wrong.)
- S6. Pluralism:** Mutually-conflicting concepts may coexist. The coexistence of mutually-conflicting concepts, satisfying requirements S1-S5 above is allowed. If two concepts satisfying S1-S5 have some common range of validity, then, in this range, the simplest of them has priority and should be considered as main, principal.

Note that in the definition of science, all the six properties are compulsory. For example, if the range of validity of a concept is the *full set* (id est, the concept is valid every time and everywhere), then, by definition, it is not scientific, as it does not satisfy the criterion S1, and there is no need to check properties S2-S6 to qualify such a concept as non-scientific.

I illustrate schematically term "science" in Fig. 5.



**Fig. 5. How to draw Science? [52]**

Scientific concepts are built on the base of observations, experiments, definitions, axioms, hypothesis, theorems and theories.

Observation means identification of some phenomena which are in some sense similar.

Definitions allow to use compact notations, making the description of scientific concept shorter and simpler.

Axioms are statements that are considered as initial at the building-up of some concept. Set of few concepts with commonly accepted axioms is called "paradigm".

Theorems are statements that are proven on the base of axioms and definitions. Sometimes, this term is used even in those cases then the proof of the statement is not yet constructed, but is expected to be constructed in future. In such a case, term "hypothesis" or "Conjecture" is more suitable.

If the hypothesis is deduced from the postulates and other, already proven theorems, it becomes theorem. If a hypothesis had predicted some non-trivial results of observations or experiments, it becomes theory.

Activity, related with development of new concepts is called research. The most important classification of sciences is based on the subject of the research, the goal and the methods, that dominate in the research: humanitarian - natural, fundamental - applied and theoretic - experimental.

In principle, such a structure could be applied to all the sciences. Not all sciences are developed sufficiently to allow the use of the full scheme above. The search for "mathematics in history" return links about history of mathematics: the historians describe history of mathematics rather than use mathematics in description of historical events. The known exception is the prediction of collapse of the USSR in century20 by Andrei Amalrik [53], "calculated" the collapse of the USSR during century 20. Since century 21, the calculus, the mathematics enter to all sciences, even to psychiatry [54].

## 8. HIERARCHY OF SCIENCES

Mathematic makes the basis of other sciences. No one science dares to contradict mathematic. The computational mathematics and cybernetics provides a bridge between mathematics and other knowledge. The general physics and theoretical physics relate mathematics with other sciences, although some sciences (even humanitarian ones) may use, for example, the statistical methods without to refer to physics. All the sciences use logics, (Boolean algebra); usually it is so obvious, that it is not even declared.

Physics is considered so fundamental as mathematics. There are several examples, when the laws of physics are broken in sci-fi literature. There is only one example detected, where the laws of mathematics are broken - in fantastic essay "Mizugadro number dream" [55]. That sci-fi had been written in order to get at least one example of braking of laws of mathematics in fantastic literature.

Hypothesis about internal contradiction of axioms of Arithmetic is not scientific: in is irrefutable; no way to reject it is supplied. However, it can be used (explicitly or implicitly) for frauds. Any inconsistency of arithmetic could be very useful at the summation of momenta of details of "Gravitsapa" (see fig.1) in order to violate the law of conservation of energy-momentum, getting a pretext to milk the budget, assigned for development of science.

Even more direct fraud can be based on tricks with arithmetics: Some official gets credit, say, a billion rubles, while billion= $10^{12}$ , and return the debt after devaluation [56] of billion for 3 order of magnitude, while billion= $10^9$ . At high level of corruption among the state officials, similar operations can be performed with other ambiguous numbers (trillion, sextillion, etc). Publications indicate, that in century 21, such (or similar) operations are, indeed, are performed [57]; many billions rubles were stolen from the Russian budget in 2018, 2019 and, apparently, used for the support of the world-wide terrorism [58]. While the corrupted [1] officials can violate rules of arithmetics in summation of momenta of details of an inertoid ("Gravitsapa"), there are no mechanism that could prevent use of the same trick counting money in the state budget. The state, that can declare, that " $2+2=5$ ", can violate all other rules and laws, suppressing the citizens. [59]

Usually, all sciences respect physics and mathematics. However, the organizers of a financial pyramid may claim, that all the participants get their benefits (that contradict the law of arithmetic). In

the similar way, the fraudsters may claim, that the sum of momenta of particles, moving inside an inertoid, depend on order of the summation, that leads to violation of law of conservation of momentum (Fig.1). However, in both such cases, the claim should be qualified as fiction or fraud.

If, in some science, some concept contradicts the basic paradigms of mathematics or physics, then, according to axiom S5, there should be indicated a way to see, that the commonly accepted paradigms are wrong. To avoid the confusions, the term science should be used only in the sense of the definition above. In all other cases, terms pseudoscience, sovietscience, christianscience, quasiscience may be used to specify, that some activity or knowledge looks similar to science or similar to a scientific research.

## 9. SCIENCES AND THE SOCIETY

Usually the sciences, and especially the fundamental ones, do not give a fast benefit. The spending of the budget funding for satisfaction of the personal curiosity of researchers requires some justification.

There were attempts to submit the development of science to other goals (creation of facilities of the modernization of the industry, or increasing of the military power of a country, etc.). Some researches, especially applied ones, can be motivated in such a way; sometimes the results have the scientific value. Often, the results of such a research are just fake.

During the human history, there was not developed more efficient motivation for science, than curiosity of researchers who do it. Yet, there is no other way to make the deep science. However, the needs of industry can be mentioned as motivation for the financial support of the curiosity of researchers.

The distribution of funds, assigned for the development of science, is serious problem. Administrators of funds cannot drill deeply into the research they finance. The funds are distributed on the base of the formal criteria: publications, citation, participation in the conferences. The ability to write the grant applications and good relations with colleagues and the distributors of funds become important, if not dominant, factor in the success in the getting of the financial support. For the same reason, the spectacular nature of a new effect is important for its promotion.

Especially non-efficiently the funds are spent in the countries with corrupted bureaucracy; and not only because the significant part of foundation is spent for bribes and the private security. The government being unable to keep the growth of the technology of the country at the international level begins to secret the scientific achievements in order to enable the monopolistic use in the military industry. The secrecy protects them from critics and opens wide field for both, intentional frauds and unwanted mistakes.

In a totalitarian country, some sciences are not only left without foundation, but are affected by the physical repression of researchers, as it happened in the USSR with the theory of relativity, quantum mechanics, cybernetics, genetics and other sciences [26]. Previously, in Europe, in the epoch of the Holy Inquisition, the similar phenomena took place with respect to astronomy and astronomers.

Perhaps, in some cases, the executors, destructing the science, indeed do not understand, that they act against the human civilization and against interests of their country; they do not consider themselves as bloody murderers, not as enemies of the people of their country. In such a case, the qualification, classification of the the human knowledge may help.

The properties S1-S6 allow to separate scientific concepts from others without fighting the pseudoscience. For this reason they are combined into definition of science above.

Qualification, classification of the human knowledge is important for the development of science. The correct, efficient terminology is required for this classification. Questions of the terminology are considered in the next section.

## 10. ABOUT TERMINOLOGY

Often, the errors are caused by a smooth, fussy definitions of terms and the concepts. The most crying examples refer to the humanitarian science. In 2009, Dmitry Medvedev had announced the setting up of a commission to counter the falsification of history [17, 18]. This makes the Russian concept of history non-refutable (not falsifiable) and disqualifies it as a science.

There is still hope, that this is just terminological confusion, and that commission does not have aim to destroy the historic science. The goal of this paper is not to provoke conflicts, but to mitigate them. I suggest not to use words “falsification”, “falsifiability”, at least in the scientific texts. Such terms are ambiguous. They may mean the negation of a concept for the contradiction to observations, as well as the misinformation. With respect to historical texts (whenever they scientific or not), the terms revisionism, opportunism and reformism appear in the similar (ambiguous) meaning .

Any term, that has two opposite or different senses, should not be used without specification, namely which of them do the authors mean. Often, the authors omit such a specification.

In this paper, the term “refutability” is used. However, if refutation of the Russian official version of history is also prohibited, then there is no way to attribute the confusion to terminology, and that concept should be qualified as non-scientific. This would not be a big loss, because the Soviet concept of history (Sovietism) anyway is just wrong; it is full of internal contradictions and disagrees with visual observation of that happened to the USSR in century 20. The goal of this research is not to convince someone to stop destroying science, to stop prohibiting critics of the “official” scientific (and not so scientific) concepts. The goal is the analysis of the historical events and elaboration of the adequate (non-ambiguous) terminology for this description. This is just scientific interest, to denote a fraud with term “fraud”. Things should be called by their proper names.

## 11. IMPORTANCE FOR PHYSICS

I would not like to teach colleagues, what to write and how to write, but just indicate, what properties make the research scientific. This section explains, why I boil up so old question, and why it is important for physics.

I used to meet several “strange” concepts, that pretended to be scientific. I mention few examples:

Estimate of the statistical significance of a “second” peak at the correlation function, using the Poissonian model of random (independent) distribution, that can be rejected due to the significant “first” peak [60].

Quantum annihilation of the optical soliton [61].

Extrapolation of the quasi-optical approximation in the atmospheric physics [62].

Quantization of the magnetic flux in a free space [64].

Violation of the Kramers-Kronig relation for the active laser materials [65].

“Non-equivalence” of the van der Waals potential to the index of refraction in paraxial atom optics [66].

“Proportional increase” of the power of a disk laser with increase of the size of the active element [67].

“Impossibility” of real-holomorphic superexponential [68]

The square root of factorial as having “no sense” [69]

The inertoids (that violate the law of conservation of momentum, Fig. 1) [70]

I had participated in discussions, originated in different branches of physics. The common feature of these cases is, that the colleagues do not specify the range of validity of their concepts, do not indicate a way to refute their concepts, do not show the relations with previous results, and discuss applications of some effect without to indicate the contradictions with the scientific facts, with already commonly-accepted concepts.

In principle, there is nothing wrong in the contradiction of some experiments to some widely accepted theory. Contrary, such a revolutionary discovery is very interesting and important; it may indicate the need to revise, improve the most important concepts. However, such a contradiction is a main result of the research. Such a contradiction should be mentioned in the title, in the abstract, in the conclusion as the main achievement of the author(s). if the authors found violation of rules of arithmetic, the title of the scientific article should cry: **The internal contradiction in axioms of arithmetic**. But the title of a scientific publication about such a revolutionary discovery should not mention the application for recovery of agriculture (destroyed by genocide, extermination of farmers), nor making the 5-year plan of production of metal in 4 years.

Idea of use an effect, that contradicts basic laws of physics, appears as subject of humor in the sci-fi novel "Tale of the Troika" [71] (Сказка о Тройке 1968) by Russian writers Boris and Arkady Strugatsky. The "Troika on the Rationalization and Utilization of Unexplained Phenomena" is described. However, the same idea is applied for the money laundering at the space research centers and other secret organizations even in century 21.

## 12. MORE EXAMPLES

For illustration of the basic ideas expressed above, in addition to cases mentioned in the previous section, I consider two more examples. The examples of the concepts that, from my point of view, are not scientific (although are declared to be scientific). One of them deals with the effective cross-sections of emission in the laser material (Fig. 6); another one refers to so-called "global warming" (Fig. 7).

An example of a non-scientific concept is shown in left hand side picture of Fig. 6. It is figure from Appl.Phys.Lett. [72], year 2006. It shows dependence of the effective cross-section of absorption and emission of light in the Yb doped Gd<sub>2</sub>SiO<sub>5</sub> crystal on the wavelength. The curves for absorption and emission, shown in the left picture, contradict the McCumber relation. Such a contradiction leads to violation of the Second Law of thermodynamics. With such a crystal, one would be able to arrange not only a good laser, but also the Perpetual Motion machine of second kind.

In order to avoid redistribution of fake curves, the left hand side picture of Fig. 6 is marked with words **MATERIAL FOR PERPETUAL MOTION**.

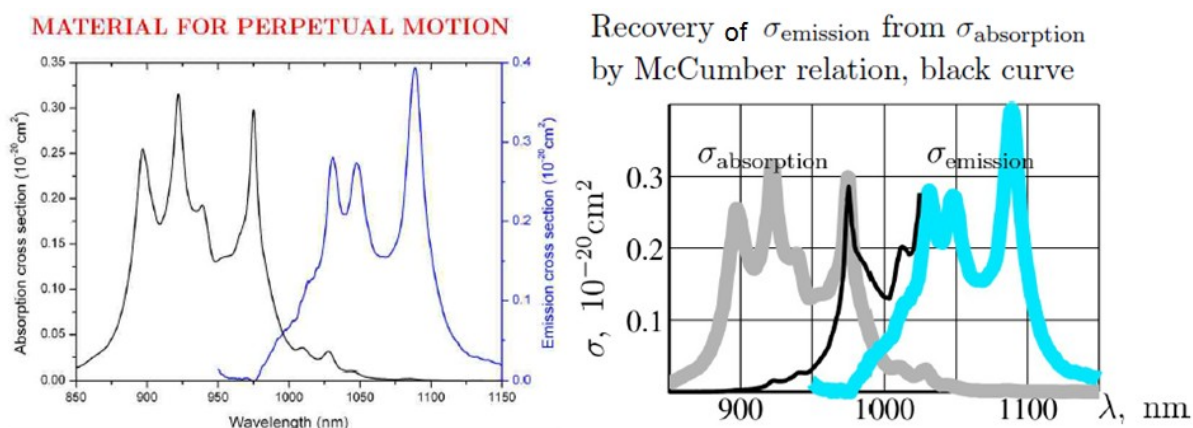


Fig. 6. Example of a fake result [88], left, and the "minimal" correction [84]

Perhaps, both curves for the cross-sections in left plot of Fig. 6 are wrong. The hypothesis, that the only emission is wrong, is considered; then, emission can be recovered from the absorption. An example of such a recovery, correction [75] is shown in the right hand side picture of Fig. 6 with black curve. This curve is not extended to the right hand side of the plot: there, values of absorption are small, and the error of the recovery is huge.

The Second Law of thermodynamics is scientific fact: no experiment, that breaks it, is known. It would be methodically correct, to claim the tremendous discovery, revision of the fundamental physical concepts. Instead, the authors claim the efficient laser material. Such a claim contradicts the 5th of the TORI Axioms (Principle of correspondence) and makes the concept non-scientific, according to the definition suggested. (However, it may still be considered as “scientific” in other system of notations, that make no difference between science and religion).

The wrong effective cross-section mentioned cannot be interpreted as an occasional mistake of a single researcher. A dozen of authors have published similar curves in various scientific journals: Applied Physics Letters [72], Optics Express [73] and Solid State Communications [74]. In such a way, the error should be qualified as methodological: Often, the results are not revised from point of view of self-consistency (Axiom S4), nor for the principle of correspondence (Axiom S5).

I think, the contradiction of results to the McCumber relation (and therefore to the Second Law of thermodynamics) should be revealed and declared by the authors before it is found by the reviewers and other colleagues.

It is difficult to believe, that among a dozen authors, six reviewers and 3 editors, no one knows about McCumber formula and its relation to the Second Law of Thermodynamics.

Perhaps, the common methodological, systematic mistake takes place. The authors consider own results as a truth, that does not need any refutation, nor even comparison with the scientific facts.

On the first glance, the left hand side of Fig. 6, if we remove words “**MATERIAL FOR PERPETUAL MOTION**”, looks more scientific, than first picture of Fig. 1 (that shows the idea of propulsion of the Russian satellite Yubileiny with device Gravitsapa on board). However, if we look at the meaning of quantities plotted as ordinates, we see, that the difference is not so big: in both cases, the fundamental laws of physics do not work.

The similarity goes further. In both cases, the inventors, instead of to claim, that the basic physical concepts should be revised, just declare, that their invention can be useful. Such a statement looks similar to the claims of organizers of a financial pyramid: they promise dividends to all the participants, and do not care about law of conservation of money; apparently, the laws of arithmetic in their calculus are broken.

Another example refers to the Global warming. Since year 2019, this concept is associated with name of Greta Thunberg [76] shown in first picture of Fig. 7.



Fig. 7. Greta Thunberg, 2019 [76] ; Japan, Tama 2013.01.14 [77] ; Peterburg 2017.07.22 [78]



Several links about Global warming are collected at Citizendium [81] and Mizugadro [82]. The common fault of the adepts of the global warming is, that no way to reject this concept is found in the bunch of literature on the topic.

From the first glance, the absence of snow during summer at Europe (say, at the latitude of Peterburg) and absence of snow anytime of year at the Japan latitude (say, at the level of Tokyo) was supposed to confirm the concept; and the presence of precipitation of water in solid state (in the conditions mentioned) should negate the concept. This happened to be not a case: after the heavy snow at Tokyo area 2013.01.14 [77] and at Peterburg 2017.07.22 [78], the adepts of the global warming still keep their claims. Since that, it is not possible to consider the global warming as a scientific concept: It is not clear, which observation would be sufficient to refute it.

In order to help the adepts of the global warming, I suggest an example: Assume, during century 21, all the seas, even in the tropical zone, happen to be covered with layer of ice. Then, one should admit, that the concept "Global warming" is just wrong. Such an example is exaggerated, but, since century 20, no other (more soft) example of hypothetic observation, that could refute the concept, is found. Rate of the "global warming" is of order of  $1^{\circ}\text{C}/\text{century}$ ; it is difficult to make any non-trivial, but still refutable prediction on the base of concept or the "global warming".

On the base of this result, the global warming is qualified as non-refutable concept. It does not satisfy axiom S3 (**Refutability**) and, by this reason, cannot be considered by scientific methods. However, the behavior of adepts of the global warming can be subject of scientific research. Avoiding both verifiability and refutability (basic principles of the scientific knowledge) can be qualified as a custom, making analogy with other customs; for example, with that shown in first picture of Fig. 2: There is some similarity in poses of the two persons shown. In the same way, the bzz about the "global warming" may look similar to science. Pseudoscience reproduces some elements of science, in the similar way, as the "Cargo cult" reproduce the exterior of airplanes (instead of to learn mathematics, aerodynamics, thermodynamics, metallurgy; - instead of to construct gliders and motors, and only then try to combine them).

Such mimicry is not an exception in the human society. A visit by a fat oligarch to a high-ranking restaurant has nothing to do with the nutrition of his body. Using the services of a prostitute has nothing to do with the reproduction of humanity. The activities of the so-called "Liberal Democratic Party of Russia" have nothing to do with either liberalism or democracy. Even the Red Rose (Lancaster) and White Rose (York) [79] clans have nothing to do with gardening. The readers will agree with me, if they try to answer: How many physicians know physics? Or estimate, in  $^{\circ}\text{C}$ , temperature of an "absolutely cold tea" [80]: +40, +18, +4, 0, -273?

The near-scientific activity of researchers and politicians, who do not care about scientific meaning of their concepts, has nothing to do with making of science; it is just money laundering. The TORI axioms are suggested to reveal and qualify such a kind of activity.

It is difficult to write a separate Erratum or article on each case; only few popular mistakes are mentioned in the publications cited. I suggest to adjust the criteria, that the scientific results are supposed to satisfy. This does not mean to make the requirements harder, but to soften the struggle between the authors and reviewers, that sometimes takes the strange form: the authors try to hide the cases, when the concept fails, while the reviewers are supposed to reveal these cases.

Criterion S1 (**Applicability**) strongly suggests, that the researchers estimate, until where their concepts are valid. Criterion S3 (**Refutability**) invites any authors to indicate, which result of which experiment would show, that they are wrong. Such indications and estimates greatly simplify the consideration (and refutation) of concepts. This makes them scientific.

This approach should help to deal with strange phenomena like observation of the "torsion fields" or the "cold nuclear fusion": either to reveal an error of the concept at very early stage, or to turn the researches into the scientific, making them different from a circus trick. The definition of science suggested allows this without to struggle against pseudoscience; such a struggle.

### 13. TECHNOLOGIES

Science is used in technologies. Technologies are so important as sciences. Technologies are older than sciences. First, Homo Habilis, and then - Homo Sapiens.

Science without technologies become meaningless. I illustrate this with two examples:

1. Jonatan Swift describes the society, where science is highly developed, but separated from technologies [83]. Such a society looks as a parody on the idea of domination of science.
2. There existed some science in the USSR. Due to the total corruption of the Soviet administration, the scientific achievements could not come to industry. So, the USSR became the “*Upper Volta with missiles*” and had collapsed.

Technologies can be qualified as customs, but they are close to both sciences and arts. On the one hand, technology uses the scientific achievements (and in this sense is close to science). On the other hand, any good technological solution is product of art. The margin between science and technology is determined by the definition of Science. Technologies have no need to demonstrate the evidences nor correctness of their concepts; the proof of technology is the efficiency in business, or, better, the efficiency of a new device. (It is conceivable to have good business with a device, that does not fulfill its utility.) The intents to boost the technology with governmental support are not efficient; they boost the pseudo-science, money laundering and other kinds of corruption. I consider the governmental foundation of technologies, especially sponsorship of the secret research, as a fraud. I think, the results of any research, sponsored by government, should be presented in a form of scientific concepts.

The classification of the human abilities and the analysis of the foundation of technologies is interesting and important topic. It falls out from the scope of this article and may be subject for the independent research.

### 14. DISCUSSION

I suggest examples, that show, that namely the TORI Axioms S1-S6 are essential for the efficient building-up the scientific knowledge. I explain, how and why do I distinguish it from other kinds of knowledge.

In certain sense, this is question of terminology. One may insist on the old, “Newtonian” interpretation of science as a “true” knowledge [22], that does not need any hypothesis nor refutations. Then, the new term is necessary to denote the phenomenon, that is denoted with word “science” in this paper and in publications by Karl Popper [12, 13, 14]

I justify the need of the TORI Axioms with analysis of the observations, presented in the list of references below. This is not fully correct: this analysis is, by itself, based on the TORI Axioms. It is unavoidable: one cannot describe the Boolean algebra, using the motivated reasoning (Female logic) [80], as one cannot describe the Female logic, using the Boolean algebra. I explain why and how I come to the TORI axioms. But I cannot prove the TORI axioms, using the motivated reasoning, mentioned above. In the similar way, I cannot prove anything to the people, who insist on some “objective knowledge”.

The TORI Axioms can be considered a religion: I cannot prove them. (The logic axioms also can be considered as a religion; one cannot prove them.) I consider this religion to be extremely efficient in building-up the scientific knowledge. In the similar way, Muslims consider Islam as the most efficient way to Heaven. In the similar way, the Soviet veterans consider Sovietism as the most efficient way to built-up the heaven (“communism”) for themselves (even if they have to convert their country to concentration camp in order to achieve this goal). The TORI Axioms can be treated as other religions - as Buddhism, Judaism, Cristianity, Marxism and Islam – if we look not at the amount of adepts, but on structure of the believes.

The readers may consider the TORI Axioms as hypothesis, and compare the efficiency of this hypothesis with other models. Other models can be more efficient in obtaining the huge grants for the scientific (and not so scientific) projects. Perhaps, for getting foundation, the motivated reasoning (“Female logics”) [80] is more efficient. Here I do not discuss, is this good or bad; I only analyze the observed phenomena.

One may consider also any alternatives, what should be called “science”, and what should not. Provide your definition of term “science”, and compare its efficiency to that I named.

If you use another definition, have you revealed, that the bzz by Valery Menshikov about “Yubileiny” and “Gravitsapa” are just fraud, money laundering, analogy of claims by Baron Munchausen?

With your definition, have you revealed, that the material with effective emission and absorption cross-sections, shown in left hand side of Fig. 6, violates not only the McCumber relation, but also the Second Law of Thermodynamics?

Or anything else? Can you suggest an example, when your definition allows to reveal a mistake or a fraud, and the TORI Axioms do not?

Or any example, when the TORI axioms disqualify some scientific result, that gives a good profit for the Humanity?

Or any similar comparison?

## 15. CONCLUSIONS

The strict definition of science with criteria S1-S6 (TORI Axioms) is suggested. These criteria are based on the idea of falsifiability developed by Karl Popper. Terms “falsification”, “falsifiability” cause confusions; in particular, they disprove the Russian concept of history. This problem may come to other sciences, for example, into physics. To avoid confusions, term “**refutability**” is better.

According to the definition above, the scientific results should include all the properties S1-S6.

Recognition of these six conditions as compulsory is necessary to save physics and other sciences from profanation.

I suggest, that the civil organizations and the courts consider as fraud any governmental foundation of any research that does not satisfy the criteria S1-S6.

I suggest, that the editorials of the scientific books and journals (and the chairs of the scientific seminars) accept S1-S6 as the main requirements for the scientific results.

This applies to all kinds of scientific researches in all countries.

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## COMPETING INTERESTS

Author has declared that no competing interests exist with respect to the text above.

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technology. And so, the generation of those who are now fifteen years old, and will be living in a communist society in ten or twenty years' time, should tackle all its educational tasks in such a way that every day, in every village and city, the young people shall engage in the practical solution of some problem of labour in common, even though the smallest or the simplest.

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Greta Thunberg to world leaders: How dare you? You have stolen my dreams and my childhood'. Sep 23, 2019. Guardian News // 'You have stolen my dreams and my childhood with your empty words,' climate activist Greta Thunberg has told world leaders at the 2019 UN



climate action summit in New York. In an emotionally charged speech, she accused them of ignoring the science behind the climate crisis, saying: 'We are in the beginning of a mass extinction and all you can talk about is money and fairy tales of eternal economic growth - how dare you!'

77. <https://mizugadro.mydns.jp/t/index.php/File:01831bikeSnow.JPG> Snow at Tokyo, 2013.01.14
78. <http://www.interfax.ru/russia/571677> В России 21:16, 22 июля 2017 Выпавший град образовал сугробы в Санкт-Петербурге. (in Russian) Heavy snow at Peterburg 2017.07.22
79. <https://www.britannica.com/event/Wars-of-the-Roses> Wars of the Roses, (1455–85), in English history, the series of dynastic civil wars whose violence and civil strife preceded the strong government of the Tudors. Fought between the houses of Lancaster and York for the English throne, the wars were named many years afterward from the supposed badges of the contending parties: the white rose of York and the red rose of Lancaster.
80. [https://mizugadro.mydns.jp/t/index.php/Female\\_logic](https://mizugadro.mydns.jp/t/index.php/Female_logic) Dmitri Beklemishev. Notes about female logic. (2013-2020). Translation from Russian.
81. [https://en.citizendium.org/wiki/Global\\_warming](https://en.citizendium.org/wiki/Global_warming) .. average air temperature near the Earth's surface rose by  $0.74 \pm 0.18$  °C ( $1.33 \pm 0.32$  °F) from 1906 to 2005. .. (state for y. 2014 – 2020)
82. [https://mizugadro.mydns.jp/t/index.php/Global\\_warming](https://mizugadro.mydns.jp/t/index.php/Global_warming) .. concept stating, that the mean temperature of the surface of the Earth rises, and the government should assign huge grants to the organizations, that declare the struggle against this rise as their main goal.
83. Jonathan Swift. A Voyage to Laputa ... "Gulliver's Travels", Part 3, Chapter 2.

## APPENDIX

Appendix is available below this link: [http://bookpi.org/doc/Appendix\\_2020\\_BP\\_4131D.pdf](http://bookpi.org/doc/Appendix_2020_BP_4131D.pdf)

### Biography of author(s)



#### **Dmitrii Kouznetsov**

Institute for Laser Science, University of Electro-Communications, 1-5-1 Chofugaoka, Chofushi, Tokyo, 182-8585, Japan.

**Research and Academic Experience:** Century 20: Proven the quantum stability of the optical soliton, Suggested the low bound of the quantum noise of a nonlinear amplifier, Indicated the limit of the single mode approximation in quantum optics. Century 21: Theorem on the boundary behavior of modes of the Dirichlet Laplacian, Deduction of limits of passive coherent addition of lasers, Theory of ridged atomic mirrors, Formalism of superfunctions, TORI axioms.

**Research Area:** Physics, Mathematics, History.

**Number of Published papers:** 101 (<https://mizugadro.mydns.jp/PAPERS/>)

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#### DISCLAIMER

This chapter compile some results described earlier in articles published by the same author(s) in the following journals.  
Place of science and physics in the human knowledge. Physics-Uspekhi, v.181, Trubune, p.1-9, 2010-2011 (in Russian)  
TORI Axioms and the Application in Physics. Journal of Modern Physics, 4(9): 1151-1156, 2013.  
Broadband laser materials and the McCumber relation. Chinese Optics Letters, 5: S240-S242, 2007.

#### Reviewer's Information

**Preface:** Some corrections by the Reviewer 1 are minor (for example, misprints). But some of his notes could not be taken into account so easily; they are copy-pasted and replied below.

**End of section 2:** Where does love enter in these four classification?

**Authors reply:** Love is custom. The flowers of love are difficult to grow-up at the ground of hate, slavery, sadism and tyranny. Love is difficult for the scientific analysis. So, it is not mentioned.

**About section 6:** I do not think Buddhists consider Buddha as God.

**Authors reply:** It does not matter. Big statues of Buddha are the proof. Lenin, Stalin, Hitler, Molotov, Ribbentrop and their partners also did not consider themselves as fascists. However, the numbers of victims the national and international socialisms greatly exceed the number of victims of regimen by Benito Mussolini, who had declared himself as fascist.

**More about section 6:** However omnipotent as she is, God cannot cancel something that already happened. So, Sovietism is not a religion.

**Authors reply:** The 'Big Brother' and his accomplices in Utopia "1984" do not declare themselves as religious adepts, but the alteration of the past is namely that they are doing constantly. The "ministry of Truth" is dedicated to canceling of things that already happened. Similar phenomena take place in the USSR, in Russia, North Korea and China. (By the way, several authors, who had published the wrong results mentioned, have affiliation at institutes of China; Marxism is official religion there.)

**About section 12:** Here, we talk about global warming, so, any "local" event cannot refute the concept. If we look at the global indicators: level of sea water, amount of CO<sub>2</sub> in the atmosphere averaged over the planet, then the evidence of global warming becomes very strong.

**Authors reply:** I saw many publications about global warming. None of them refers to a site, where the data about sea level in various places (that could help to confirm or to negate the concept) are available in a free access. Nor sites with data about mean temperature are cited. I add reference to Citizendium, that indicates, that the raise of the mean temperature is of order of 1°C/century. If the tendency remains, then, in year 3000, one may have need to consider it seriously. The bzz about "global warming" begins in year 1988. You may find the data of temperature for years 1989-2020, fit them with linear function and with quadratic function, and check, whether or not the raise of temperature accelerated during 30 years since the first alarm. It seems, the adepts of the "global warming" do not cite these data.

**More about section 12:** It is easy to show that global warming is a fact: just look at the time series of the Earth's temperature over the last 40 years. It is increasing year after year. If the Earth's global temperature next year, and in two years, etc., then this will be a refutation. Easy.

**Authors reply:** 40 years, it is too short interval for the climatic activities. Aleksander Pushkin gives an example, when, in the Peterburg region, the rains continued until the end of year, and only in January, the precipitation changed from water to snow. That happened hundreds year ago. There are many such historic evidences. But I see no collections of these evidences in the literature about the global warming. And, again, the adepts of the Global Warming do not provide links to the sites, where the temperature data are available. They do not indicate, which "optimistic" models (that do not imply a global catastrophe) were used to fit the data; no estimate of the statistical significance of rejection of these models is found. The same refers to data about the level of water in oceans.

P.S.: The graphic of the mean temperature by Dawn Stover

(<https://thebulletin.org/2014/09/the-global-warming-hiatus/>) D.Stover. The global warming "hiatus". 2014.09.23) looks similar to that of any other random process with wide spectrum, see

[https://www.schweizerbart.de/papers/metz/detail/7/89038/Method\\_of\\_random\\_wave\\_vectors\\_in\\_the\\_simulation\\_of](https://www.schweizerbart.de/papers/metz/detail/7/89038/Method_of_random_wave_vectors_in_the_simulation_of)

D.Kouznetsov, V.Voitsekhovich. Method of random wave-vectors in the simulation of correlated random processes. Meteorologische Zeitschrift Vol. 7 No. 5 (1998), p. 230 - 236.

**Authors comment:** Thank to Reviewer 1 for the good job and the important comments.