The new SI – another proposal on the future revision of the International System of Units

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ABSTRACT

This article is an alternative to the proposal of 24th meeting of the General Conference on Weights and Measures (CGPM) for a future revision of the International System of units (SI). It concerns the "Resolution 1" of 24th meeting of CGPM and the "Draft Chapter 2 for 9th SI brochure, following redefinitions of the base units". The article represents a completely new approach for creation of a new SI of proper physical units, based on proper principles of definition. A new SI-structure and new proper units' definitions are proposed for discussion during the next meeting of the CGPM. Actually, the article represents a concept of next generation SI, oriented to the future.

Keywords: *SI system; base units; measurement systems; relativity; speed of light; fundamental constants.*

PACS: 04.20.Cv - "Fundamental problems and general formalism"; 06.20.F - "Units and standards"; 06.20.Jr - "Determination of fundamental constants"; 06.30.Ft - "Time and frequency"; 06.20.fa - "Units".

The article was submitted to a number of physics journals with a highest impact factor. The argument of the last rejection (March 20, 2015) was that the journal "*is not an appropriate forum for this debate*". The publication of the article has been rejected and by "Metrologia" (see the Appendix of the previous version 4), but after sending it directly to the BIPM Committees, the „*Draft Chapter 2 for 9th SI brochure following redefinitions of the base units*" was not actually discussed by 25th meeting of the CGPM (18-20 November 2014), what was a good achievement.

The question is: What is the advice of the reader about *"the appropriate forum for this debate"?*

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1. INTRODUCTION

All systems of measurement, including International System of Units (SI), are based on our perception of full certainty and constancy about the physical units and physical constants. This perception of certainty and permanency is a result of the perfect indisputable mathematical and experimental evidence, which in turn is a consequence of the fact that the physical laws remain perfectly the same in case of change of the intensity of gravity in the local time-spatial domain.

Actually, the physical reality is that the electromagnetic field exists on the gravitational field. It means that the properties of atoms depend on the intensity of the gravitational field where the atoms are located. It means that the electromagnetic radiation is emitting, spreading and absorbing in full conformity with the local intensity of the gravitational field. The reality that the frequency and the velocity of electromagnetic radiation are changing with the change of the gravitational potential (with the change of the intensity of the gravitational field), theoretically was predicted by Einstein [1]. Experimentally, it was proven by Shapiro in 1964. The Shapiro time-delay effect is caused by the lower speed of radar signals passing near a massive object (the Sun), through a stronger gravitational field – and this is the registered fact.

> *"The experiment was designed to verify the prediction that the speed of propagation of light ray decreases."* [2].

Conversely, the speed of the electromagnetic signals increases in the areas with weaker gravitational field (for example to the space-probes toward the border of the Solar system).

In contrast to the position adopted by the physical society, the facts clearly show that in stronger gravitational field ν, λ and c of the electromagnetic radiation decrease; respectively μ_o (permeability of free space, also called the magnetic constant) and ε_o (permittivity of free space, also called the electric constant) increase. Conversely, in weaker gravitational field ν, λ and c of the electromagnetic radiation increase, respectively μ_o and ε_o decrease. The logical summary of all the evidence is that the properties of the atoms, the physical units (defined through the changing characteristics of the electromagnetic radiation) and all the physical constants are changing in perfect synchrony with the change of the gravitational field intensity, with the warping of the space-time "in full synchrony with the contraction/expansion of the space-time" [3]. This fact, however, **does not allow registering by measurement whatever changes in the properties of atoms, as well as whatever changes of the physical constants in the time-spatial domain, where the physical units are defined**. The awareness of this reality was published in *"The Speed of Light and Uncertainty Principle of the Macro-world"* [3]. It is actually a new **model of uncertainty of the Universe**, which gives answer of the question about the origin of the energy and includes decisions of a lot of problems in the physics today (such as: "the accelerated expansion of the Universe"; "the dark matter and the dark energy in the Universe", etc.), which have been under research for a long time.

Nowadays, complex relativistic models are created for different purposes for celestial mechanics, space navigation, etc., and also for the everyday needs for positioning purposes on the Earth. Very complex definitions, standards and conventions, time and frequency techniques, and sophisticated mathematical methods are needed to increase the measurement accuracy. Therefore, we need to discover the laws of change of the physical units with the change of the intensity of the gravitational field (with the change of the gravitational potential); we have to reconsider the law of conservation of energy in a global sense, which will give us an explanation what is the energy at all; explanation about the origin of energy; explanations of a lot of problems in the physics today.

The conclusion is that the perception of *"certainty and constancy"* (which is a result of the irrefutability of all perfect "mathematical and experimental evidence about this certainty" in any local space-time domain where the physical units are defined) **- does not give us the right to accept our local physical units as absolute and our local physical constants as fundamental**.

Therefore, with the new generation SI we will need to standardize methods for calculation of the changes of the physical units in any time-spatial domain with different gravitational potential (with different intensity of the gravitational field), despite the uncertainty of that change.

That is why, in this article is suggested a completely new approach to a proper hierarchy of units in a new SI of proper physical units, based on proper principles of definition. This proposal is based on the awareness of the physical reality of global relativity in the Universe.

The proposal for redefinitions of the base units of SI, represented in *"Resolution 1 of 24th meeting of the CGPM 2011"* and in the *"Draft Chapter 2 for 9th SI brochure, following redefinitions of the base units 2010"* is not acceptable. Mainly, three dissents are concerned:

- The first dissent is related to:

"that SI base units can be defined in terms of the invariants of nature - the fundamental physical constants or properties of atoms." [4].

In this aspect, the definition of the base unit of length is indicated as:

"a prominent example of the success of such efforts is the current definition of the SI unit of length, the metre (17th meeting of the CGPM, 1983, Resolution 1), which links it to an exact value of the speed of light in vacuum c, namely, 299 792 458 metre per second."[4].

But in the Universe, as mentioned above, the so called "fundamental physical constants" and the "properties of atoms" are not "invariants of the nature". The physical constants (including the speed of light) are only local constants.

- The second dissent is related to the proposed way of definition of the base units of mass, current, temperature and mole by means of fixing numerical values of physical constants.

"Recognising the importance of linking SI units to such invariant quantities, the XXth CGPM, in 20XX, adopted new definitions of the kilogram, ampere, kelvin, and mole in terms of fixed numerical values of the Planck constant h, elementary charge e, Boltzmann constant k, and Avogadro constant NA, respectively."[5].

In fact, the exact numerical values of these constants are determined under the condition that the units (which we actually want to define) are already known. Obviously it is an ordinary case of "***circular reference***". The national metrologies have been "encouraged" to determine these constants with better accuracy, but unfortunately by means of the known (old) units.

- Thirdly, the choice of the base units should be a scientific choice, but not guided by history and tradition:

"The choice of which units to take as base units is to some extent arbitrary. This choice has been governed by history and tradition in the development of the SI over the last 120 years." [5].

2. BASIC PRINCIPLES FOR CREATION OF THE NEW SI OF PROPER UNITS

From a scientific point of view, the choice of the base physical units should not be arbitrary. The proper set of the base physical units of the new SI, should be determined first of all on the basis of the awareness of the physical nature of the Universe; secondly, should be determined on the basis of the awareness of certain fundamental facts and thirdly, obligatory on the basis of adopted proper principles.

2.1. The Physical Nature of the Universe is the Basis of Determination of the Set of the Base Units of a New SI

Everything in the Universe vibrates in macro- and micro-worlds (the Universe is dynamic). The electromagnetic field exists on the gravitational field. The change of the frequency and the wavelength of the electromagnetic radiations represents the change of space-time warping.

For creation a proper set of base physical units for our Local Physical Reality, first of all, we have to rely on a genuine definition of the Global Physical Reality of the Universe. One suitable example of definition of the global physical Reality can be:

> "The Universe is warped by **matter time-spatial** gravitational **force**-field, on which other fields exist (such as the electromagnetic field), and where the **energy** is accumulating and transforming."

The proper set of base physical units should be established on the basis of the so-defined nature of the physical reality in the Universe. Therefore, according to this definition, the set of base measurement units should include the units of **time**, space (**length**), **force**, **mass** and **energy**. The base measurement units should be at the top of the SI-hierarchy. They should be defined independently of the other units and constants. All the derived units should be defined by means of the base units. The mass and the gravitational force are linked to each other, as well as the time and space are linked. The energy is a multi-layer physical quantity and exists in many forms. It accumulates and manifests at macro- and micro-levels, and in different force fields. Here can be mentioned the words of Richard Feynman:

> *"It is important to realize that in physics today, we have no knowledge what energy is."[6].*

However, we can mention that the answer of the question about the origin of the energy, can be seen through the section "Epilogue: Theory of Everything or Theory of Nothingness" of the article "*Awareness of Special and General Relativity and Local and General Physical Reality.*"[7].

2.2 Awareness of the Fundamental Facts

Here we should pay attention and realize the following fundamental facts:

- Fact 1: First of all, we should realize the fact that in the global physical reality everything is relative.

As was mentioned above, the physical constants and units, as well as the properties of atoms are different in areas with different intensity of the gravitational field. They are different in the local time-spatial domains with different intensity of the gravitational field. They change in the local time-spatial domains when the intensity of the gravitational field is changing as a result of the global motion in the Universe. Therefore, all the physical units and all the so called "fundamental physical constants" are only floating local units and constants - they are constant only for the local time-spatial domain where the units are defined.

- Fact 2: Second, we should realize the important fact that in the global relativity in the Universe, only the numbers remain to be absolute.

Therefore, it is preferable that the physical units should be defined **by counting** - by fixing the numerical value of certain characteristic of particular physical quantity. The **comparison** is another way, which can be used in the independent definitions of the base units. The accuracy of comparison has to be involved in the determination of the level of uncertainty when defining the units.

- Fact 3: Third, we should realize that every result of measurements of physical quantities is represented: first - by numbers, and second - by measurement units.

The measuring numbers are real numbers which although we accept them with a certain approximation in the process of measurement – the measuring numbers are absolute by themselves. However, the physical units defined by means of the characteristics of electromagnetic radiation are floating in synchrony with the change of the gravitational field intensity. Therefore, since the laws of physics remain the same - the physical constants also change in line with the change of the intensity of the gravitational field. However, we should be aware that we cannot determine the change of any "physical constant" through experiments carried out in the same time-spatial domain, where the physical units are defined [3]. Actually we will obtain another result of the measurement (as a different number), if we can use the units defined in the time-spatial domain with other intensity of the gravitational field. Thus, if we use the units defined in the time-spatial domain on the Earth's surface, we get an "effect of propagation delay of electromagnetic radiation" when the electromagnetic radiation passes through an area with stronger gravitational field [2], or an "effect of anomaly in acceleration of the space-probes" if the electromagnetic radiation passes through an area with weaker gravitational field (if we are sending it to the boundary of the Solar system and receiving the reflected electromagnetic radiation).

- Fact 4: Fourth, we should distinguish the physical units from the geometrical units.

The geometrical units are dimensionless, i.e. they are only numbers. Therefore geometrical measurement units are absolute. For example, geometric measurement units are the radian (the standard unit of plane angular measurement) and the steradian (the SI unit of solid angle measurement). The radian and the steradian were in the category of the supplementary units, but in 1995 this category was abandoned and the units were grouped as derived units, although they are dimensionless!

Important note: This article discusses only the physical units of measurement – the **geometrical units of measurement are rather related to the mathematics**.

- Fact 5: Fifth, we should distinguish the mathematical constants from the physical constants.

The mathematical constants are dimensionless, i.e. they are only numbers (the number $\boldsymbol{\pi}$, Euler's number **e**, etc.) That is why, the mathematical constants are absolute (such as the numbers).

2.3 Principles of Building of the New SI-System Structure

Every logical structure should be built on the basis of certain principles. The principles of creation of a proper SI of proper units can be grouped into three principal groups:

Principles, group 1: "general requirements for definition of our local physical units."

- The definition of any physical unit should be defined under exact certain initial conditions with a certain experiment within a certain time-spatial domain (with certain gravitational potential) in a definite frame of reference.
- The most appropriate "time-spatial domain" (with certain intensity of gravitational field), that should be used to define the SI-units in our local physical Reality - is "*at the sea level*".
- All the units (except for the base units), should be defined by means of before established units. Constants can be used only if they are expressed by previously defined units too.
- It should not be permitted a presence of "***circular reference***" when defining the physical units. For example, it is unacceptable the present definition of the unit of length "metre" by means of the constant "speed of light", which is with dimension "metre" per "second" (i.e. calculated by means of previously known (defined) unit "metre").

Principles, group 2: "requirements about the definition of the base physical units".

The base units are at the top of the hierarchy of the measurement system' structure.

- The base physical units should not be defined by means of other physical units or physical constants - they must be independent.
- The choice of the base physical units should be consistent with the so-defined nature of the physical reality in the Universe (see subsection 2.1). It means that at the top of hierarchy of the system by importance should stay the units of **time**, space (**length**), **mass**, **force** and **energy**.
- The base physical units must be defined by fixing the exact number (the numerical value) of (magnitude, size or amount) of a certain characteristic of a particular physical quantity; with exact specified experiment under precise initial conditions.

For example, the physical quantity time has the characteristic duration. When defining the base unit of time, we fix the duration of certain number of periods of a particular electromagnetic radiation under precise conditions.

- The method of comparison between the same effects caused by different physical quantities can be used when we define a certain base unit.

For example, the base unit of mass can be defined as a mass of crystal of ^{28}Si with fixed number of atoms (by counting), which feels the same gravitational attraction as the international Prototype in the time-spatial domain "at the sea level" (by comparing). The rationale for this way of defining the "kilogram" is given in the next section.

Comments:

(1) The basic importance of the unit of force is obvious. It makes the link/connection between the units characterizing the gravitational field and the units characterizing the electromagnetic field. The connection between the gravitational field and the electromagnetic field can be done by comparing the forces generated by the gravitational field and by the electromagnetic field. However, the unit of force cannot be independent - it is not possible to be defined independent of the base units of time, length, mass or temperature. That's why, the unit of force cannot be considered as a primary base unit.

(2) In general terms, the energy is the capacity to make change in the material world. As was aforementioned, the energy is a multi-layer physical quantity and exists in many forms. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other forms. The temperature is physical quantity that indicates the level of hot and cold on numerical scale (in degrees). It is a physical quantity that corresponds to the kinetic energy contained in a thermodynamic system. Moreover, "kelvin" can be defined as an independent unit. That's why, the unit of temperature "kelvin" should be added to the group of the base units.

(3) Another important connection between macro- and micro-worlds can be made through the definition of the unit of mass (see subsection 3.3 below).

The conclusion is that according to the aforementioned principles, the base units should be the units of time, length, mass and temperature, because they are based on the physical nature of the Universe and can be defined independently of other units.

Principles, group 3: "requirements about the definitions of the derived physical units".
In the new proper system of measurement, all the units defined by means of other units or constants should be accepted to be derived units.

- All derived units should be defined only by means of previously defined units (preferably by means of base units). Constants can also be used if they are expressed only by means of previously defined units. Therefore, a strict logical consistency at units' definition must be observed, in order a proper hierarchy of the new SI to be formed.
- Some derived units can be defined in different ways - by using different sets of previously defined units. Therefore, the following principle should be observed: "the less is the number of the used base units, the more accurate will be the definition and higher in the hierarchy will be the derived unit".

Following the aforementioned principles and facts, we can make a starting example of initial structure of a new generation SI.

3. RESULTS AND DISCUSSION: STARTING EXAMPLE OF HIERARCHY AND UNITS' DEFINITIONS IN THE NEW SI

In this section, the current definitions of the SI units "BIPM SI brochure 8th ed. 2006" [8], and the proposed new definitions in "Draft Chapter 2 for 9th SI brochure, following redefinitions of the base units" [5], are discussed. On their basis and according to the above mentioned concept about creation of a new SI of proper units - new suggestions for definition of the base units and some of the derived units are represented.

3.1 The Base Unit of Time (Second)

The change of frequency of the electromagnetic waves represents the change of the space-time warping. The accepted way of definition of our local unit of time is by fixing the duration of certain number of periods of certain electromagnetic radiation (with certain frequency). The suggested definition in [5] is:

> *"The second, s, is the unit of time; its magnitude is set by fixing the numerical value of the ground state hyperfine splitting frequency of the caesium 133 atom, at rest and at a temperature of 0 K, to be equal to exactly 9 192 631 770 when it is expressed in the unit s^{-1}, which is equal to Hz."*

The current definition in [8] is:

> *"The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom."*

At the meeting in 1997the CIPM affirmed that:

> *"This definition refers to a caesium atom at rest at a temperature of 0 K."*

This addition is because the thermodynamic energy status of the caesium atom needs to be determined.

Undoubtedly, the two definitions are similar and acceptable. However, according to the principles of building of the new SI-system structure (subsection 2.3), the local time-spatial domain with certain intensity of the gravitational field (where the experiment is performed) should be added in the definition - it is "at the sea level".

The unit "second" is a base unit, because its definition is independent of other units or constants. The uncertainty of definition of the unit of time "second" only depends on the accuracy of counting of these 9 192 631 770 periods.

3.2 The Base Unit of Length (Metre)

The proposed definition in [5] is:

> *"The metre, m, is the unit of length; its magnitude is set by fixing the numerical value of the speed of light in vacuum to be equal to exactly 299 792 458 when it is expressed in the unit ms^{-1}."*

Further is explained:

> *"Thus we have the exact relation c = 299 792 458 m/s. The effect of this definition is that the metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second."*

Seemingly, the "metre" can be defined by using the local constant "speed of light". However "the speed of light" has a dimension "metre per second" (i.e. it is determined by means of previously known (defined) unit "metre"). Therefore, the definition of the "metre" in [5], as well as the current definition in [8], consist a "***circular reference***".

The proper, independent way of definition of the unit of length, in accordance with above mentioned principles, is by fixing the length of the certain number of wavelengths in vacuum of a particular electromagnetic radiation in the time-spatial domain "at the sea level". That's why, the preferable definition of the "metre" is that which was adopted by [9]. Definitely, the local time-spatial domain of the experiment should be added – it is "at the sea level":

> *"The metre is the length equal to 1650763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels 2p10 and 5d5 of the krypton 86 atom at the sea level."*

If this definition of the base unit of length is determined in the reference system bound to the Earth's surface, it is obligatory the "metre" to be determined "at the sea level", by taking the arithmetical average of the measured sum of 1650763.73 wavelengths in two opposite directions - "to East" and "to West", (Sharlanov G. V. "The Speed of Light Postulate - Awareness of the Physical Reality", Available: http://rxiv.org/pdf/1401.0073v4.pdf).

Certainly, it can be suggested another appropriate electromagnetic radiation, but according to this definition, the "metre" is a base unit, because this definition is independent of (not uses) other units or constants. The uncertainty of definition of the unit of length "metre" depends only on the accuracy of counting/reading of these 1650763.73 wavelengths.

3.3 The Base Unit of Mass (Kilogram)

The suggested definition in [5] is:

> *"The kilogram, kg, is the unit of mass; its magnitude is set by fixing the numerical value of the Planck constant to be equal to exactly 6.626 06X x 10^{-34} when it is expressed in the unit $s^{-1}m^2kg$, which is equal to J s.".*

Planck's constant has dimension ($s^{-1}m^2kg$) – i.e. it is defined by means of the previously known (defined / accepted) unit of mass "kilogram". Therefore, the proposed definition of the "kilogram" in [5] consists "***circular reference***" too and cannot be accepted.

Before another definition of the unit of mass to be suggested, let us analyze the physical quantity mass:

- On one hand, material bodies with their masses create gravitational force field and warp the space-time. On other hand, we associate the physical quantity mass of a body, with the effect that this body feels by the impact of force on it. The gravitational force of attraction of a material body is a measure of the mass of this body. The material bodies with equal mass feel the same force of attraction in a place with a certain intensity of the gravitational field, and receive a same acceleration. If a force with the same magnitude (but not gravitational force), is applied to the same material body at the same place - the body will get the same acceleration. Therefore, it is naturally to conclude that the gravitational and inertial masses are not only equal – they are the same physical quantity.
- In our local time-spatial domain, the gravitational field is determined by the close proximity of the huge mass of the Earth. The gravitational force, with which the Earth attracts each body, is proportional to the mass of this body. Let us examine two material bodies at the same place (same gravitational intensity), with the same structure, consisting of the same isotopic pure substance. They feel the forces of attraction proportional to the quantity of substance contained in the each body (proportional to the number of atoms or molecules contained in the bodies). Therefore, the force of attraction of a body of same isotopic pure substance is a measure of the mass of this body (which corresponds to the number of atoms or molecules). Thus, if we need to be aware of the mass as a physical quantity, it inevitably brings us to the logical conclusion that **the mass of a material body is actually the amount of substance in it**.

Today - excellent results are achieved:

> *"The results obtained for the spheres AVO28-S5 and AVO28-S8 involved in the comparison have demonstrated that by using air buoyancy artefacts and sorption artefacts it is possible to achieve a relative uncertainty of 4.1 × 10^{-9}."[10].*

Therefore, we can define the unit of mass in the small time-spatial domain "at the sea level" by fixing (determining) the exact number of atoms in a sphere of pure isotopic crystal ^{28}Si, which feels the same force of gravitational attraction as the "international Prototype of the kilogram". Consequently, in full conformity with the aforementioned principles, the following definition of the unit of mass "kilogram" can be proposed:

"The kilogram is the mass of isotopically enriched silicon crystal ^{-28}Si with equivalent gravitational attraction to the gravitational attraction of the international Prototype of the kilogram, compared in the small time-spatial domain at the sea level. The determination of the exact number of atoms in this crystal will be the definition of the kilogram."

The uncertainty of this definition of the unit of mass "kilogram" depends on the accuracy of counting atoms in the silicon artifact and on accuracy of comparing the gravitational attraction to the Earth of the *Prototype of the "kilogram"* to the silicon artifact. In this way of definition, the unit of mass will be a base unit not only because of its significance (subsection 2.1), but also because it is defined independently of other units or constants.

3.4 The Base Unit of Thermodynamic Temperature (Kelvin)

We know that the thermodynamic temperature characterizes the kinetic energy (the motion) of the system's particles. In other words, the thermodynamic temperature is a physical quantity that characterizes the local thermal energy of matter. The change of the thermodynamic temperature represents the change of thermodynamic (internal) energy in a thermodynamic system.

The current definition [8] of the unit of thermodynamic temperature is:

"The Kelvin, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water."

At 94th meeting in 2005 meeting, the CIPM affirmed that:

"This definition refers to water having the isotopic composition defined exactly by the following amount-of-substance ratios: 0.000 155 76 mole of ^{2}H per mole of ^{1}H, 0.000 379 9 mole of ^{17}O per mole of ^{16}O, and 0.002 005 2 mole of ^{18}O per mole of ^{16}O." [11].

The suggested new definition of the unit of thermodynamic temperature in [5] is:

"The kelvin, K, is the unit of thermodynamic temperature; its magnitude is set by fixing the numerical value of the Boltzmann constant to be equal to exactly 1.380 6X $\times 10^{-23}$ when it is expressed in the unit $s^{-2}m^{2}\,kg\,K^{-1}$, which is equal to $J\,K^{-1}$."

The uncertainty of the new definition is based on the accuracy of determination of the Boltzmann constant. But the dimension of Boltzmann constant is [$s^{-2}\,m^{2}\,kg\,K^{-1}$] - i.e. it is determined by means of previously known (defined) unit of temperature "kelvin". Therefore, the proposed new definition of the unit of thermodynamic temperature "кelvin" in [5] consists "***circular reference***" too.

The conclusion is that a preferable definition is the present definition. Furthermore, using the present definition - the unit of thermodynamic temperature is independent of other units and constants. Therefore, the unit of thermodynamic temperature is the fourth base unit defined independently of the other physical units and constants. Thus, in the hierarchy of the new SI-system we can accept four base units.

The derived units are at different levels of the SI-hierarchy depending on the number of used base units in their definition. Further down in the article, definitions of some of the most important derivative units are considered.

3.5 The Derivative Unit of the Amount of Chemical Substance (Mole)

The mole is a unit of measurement used in chemistry to express amounts of chemical substance.

Following the proposals of IUPAP, IUPAC and the International Organization for Standardization (ISO), the CIPM gave a definition of the "mole" in 1967 (and confirmed in 1969). Finally, the present definition of the "mole" was adopted by 14th CGPM 1971 Resolution 3:

"1. The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12; its symbol is "mol".

2. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles." [12].

In 1980 the CIPM approved the report of the CCU (1980) which specified that:

"In this definition, it is understood that unbound atoms of carbon 12, at rest and in their ground state, are referred to."

The definition of the "mole" also determines the value of a constant that relates the number of entities to amount of substance for any sample. This constant is called an "Avogadro constant", which has a value of NA = $6{,}023\times10^{23}$ mol^{-1} elementary entities of any substance.

The suggested definition of the "mole" in [5] is:

"The mole, mol, is the unit of amount of substance of a specified elementary entity, which may be an atom, molecule, ion, electron, any other particle or a specified group of such particles; its magnitude is set by fixing the numerical value of the Avogadro constant to be equal to exactly 6.022 14X x 10^{23} when it is expressed in the unit mol^{-1}"

If we have to determine with greater precision the number of elementary entities in one "mole" – the "mole" has to be known (previously defined). Therefore, the proposed definition is another case of "***circular reference***", and this definition cannot be accepted. For that reason, the current definition of the unit of amount of chemical substance [8] is preferable. According to this definition, the "mole" will be "derived unit level one" in the hierarchy of units in the new SI-system, because the definition uses one base unit - the unit of mass "kilogram".

The uncertainty in the present definition of the unit "mole" depends on the accuracy of determining the unit of mass "kilogram" and on the accuracy of counting the number of atoms in 0.012 kg of carbon-12.

A more accurate determination of the number of atoms can be done, if we count the atoms in 0.028 kg of crystal of pure ^{28}Si. Thus the definition of mole can be the following:

"The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.028 kilogram of ^{28}Si; its symbol is "mol"."

In this definition, it is understood that unbound atoms of ^{28}Si, at rest and in their ground state, are referred to. By means of this definition, the value of the "Avogadro constant" can be determined with greater precision.

3.6 The Derivative Unit of Force (Kilogram Force)

In 1946, with resolution 2, the Conférence Générale des Poids et Mesures (CGPM) standardized the unit of force in the MKS system to be:

"the force needed to accelerate 1 kilogram of mass at the rate of 1 metre per second squared."

The (9th CGPM 1948 Resolution 7) adopted the name "*newton*" for this unit [13]. This definition uses three base units ("kilogram", "metre" and "second"). Therefore, in this way of definition, the unit of force "newton" turns out to be a derived unit of the third level in the new SI-hierarchy (according to "Principles, group 3" in subsection 2.3).

The most independent way to define the unit of force is the definition of the gravitational unit of force, by means only of one base unit– the unit of mass (*the less used base units – the higher accuracy at definition*). Thus, the proposed definition of the unit of force can be:

"One kilogram-force is the force equal in magnitude of the gravitational force exerted on one kilogram of mass in the gravitational field at the sea level."

Defined in this way, the unit of force "kilogram force" is "derivative unit level one", because the definition uses only one base unit – the unit of mass "kilogram". The uncertainty of definition of the unit of force "kilogram force" depends on the accuracy of definition of only one base unit – the unit of mass, and on the accuracy of comparing. So, the proposed definition is preferable.

Here we can insert the bit of awareness that the existence of the unit of force "newton" is **a consequence of the arbitrary choice** of the unit of length "metre". First, let's imagine that we have chosen a new unit of length – "new metre", which is 9.80665 times larger than the present unit of length "metre". Secondly, let's define the unit of force "new newton" in the same way as the unit "newton" is defined, but using the unit "new metre"*, as*:

"the force needed to accelerate one "kilogram" of mass at the rate of one "new metre" per "second" squared."

As a result, there will be no difference between the units of force "new Newton" and "kilogram force" - and the question about the difference between the gravitational and inertial masses, would not have been arose at all ...

3.7 Derivative Unit of Electric Current (Ampere)

The unit of force is very important and from other point of view - because it gives connection between the physical units of the electromagnetic field and the physical units of the gravitational field. These fields are force fields. Therefore, if we choose the unit of electric current "ampere" to be the most important quantity of the electromagnetic field, we should define this unit by means of comparing forces. Defining the unit "ampere", through an experiment comparing the gravitational and electromagnetic forces, is not only a strategic approach, but in this way minimum previously defined units are used (*the less used base units – the higher accuracy at definition*).

The current definition of the unit of electric current "ampere" is:

"The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2 × 10^{-7} newton per metre of length."[8].

The suggested definition of the unit of electric current in the (Draft Chapter 2 for 9th SI brochure) is:

*"The ampere **A**, is the unit of electric current; its magnitude is set by fixing the numerical value of the elementary charge to be equal to exactly 1.602 17X ×10^{-19} when it is expressed in the unit **sA**, which is equal to **C**." [5].*

In the new definition, the uncertainty of definition of the unit "ampere" is based on the accuracy of definition of the unit of elementary charge, which has to be equal to 1.602 17X ×10^{-19}**C**. However, the unit "coulomb" has a dimension [**s A**] - i.e. it is determined by means of the previously known (defined) unit "ampere". Therefore, the definition of the "ampere" in [5] consists "***circular reference***" again. Therefore, this definition is unacceptable, and the present definition of the unit "ampere" is preferable. We should only add to that definition the words "at the sea level" to designate the small time-spatial domain, where the experiment is carried out.

Actually, it would be better, if the following proposed definition will be discussed:

"The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to (2 × 10^{-7}), divided by 9,80665 kilogram force per metre of length, at the "the sea level."

Thus, the unit of electric current "ampere" is "derived unit level two" in the new SI-hierarchy, because at its definition, the used base units are actually two – the unit of length "metre" and the unit of mass "kilogram" (used for definition of the unit of force "kilogram force"). Therefore, the uncertainty of definition of the unit of electric current "ampere" will depend on the accuracy of definition of two used units "kilogram force" and "metre".

In this way we can go on to define all the physical units and place them in appropriate level in the new SI-hierarchy. In this way all the physical units will be proper units and will be floating, depending on the intensity of the gravitational field in any certain time-spatial domain in the Universe. In the future, we have to know how the physical units will differ at the surface of other planets ...

4. CONCLUSION

The publication of the article has been rejected by a number of physical journals, but after sending it directly to the BIPM Committees, the „Draft Chapter 2 for 9th SI brochure following redefinitions of the base units" was not actually discussed by 25th meeting of the CGPM (18-20 November 2014),... which is a good achievement.

ACKNOWLEDGEMENTS

The author would like to thank Phil Gibbs for the opening the bottle, where the free spirit of the science was closed by the dominant orthodox part of the scientific society.

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(The article was submitted to "Metrologia" (rejected without any discussion), before the newest *"Draft Chapter 2 for 9th SI brochure following redefinitions of the base units"* to be publicized in 2013. That is why the reference is to the previous version of *"Draft Chapter 2 for 9th SI brochure following redefinitions of the base units"*, published in 2010).

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