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Measurement of Type of Substance Based on Protons, Neutrons and Electrons in the Substance

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: The study aims to determine a method to identify and measure all substances.
Study Design: Applying the new structural constant of atoms, s_0 = 8.278 691 910, the possibility of introducing *type of substance* as a new physical quantity and its unit boscovich is studied.
Place and Duration of Study: University of Applied Sciences, Zagreb, Croatia, 2015–2017.
Methodology: Theoretical studies showed that the velocity of an electron in an atom cannot exceed the speed of light, implying that no atom of atomic number more than $Z_{max} = 2s_0^2$ can be generated. It provides the substrate for the unit boscovich, $B = 1/Z_{max} = 0.0072953572330$.
Results: Any substance whose physical or chemical structure is known can be expressed in terms of *type of substance*, with value S (standing for Soddy's number). The ratio S/B is obtained as a numerical factor $f = f(\boldsymbol{p},\boldsymbol{n},\boldsymbol{e}) = \boldsymbol{p}/10^0+\boldsymbol{n}/10^4+\boldsymbol{e}/10^8+\boldsymbol{D}/10^{12}$, where $\boldsymbol{p}$, $\boldsymbol{n}$, and $\boldsymbol{e}$ are the numbers of protons, neutrons, and electrons, respectively, and $\boldsymbol{D}$ is a *distinguishing number*, where $\boldsymbol{D} = D(\boldsymbol{p},\boldsymbol{n},\boldsymbol{e})$. The function $f(\boldsymbol{p},\boldsymbol{n},\boldsymbol{e})$ represents the *numerical value* of the physical quantity *type of substance*, so the following expression applies: $S = f(\boldsymbol{p},\boldsymbol{n},\boldsymbol{e})$ B.
Conclusion: Atomic research and knowledge of the maximum atomic number Z_{max} induced the introduction of *type of substance* as a new physical quantity and its unit boscovich, B. This allows all existing substances (i.e., vacuum, elemental particles, chemical elements, nuclides, molecules, compounds, and ions) to be expressed as with any other physical quantity.

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1. INTRODUCTION

Substances, i.e., particles, elements, atoms, nuclides, and molecules, compounds, and ions, as well as alive and non-living matter, have tens of millions of shapes and properties. Some of the substances are waiting to be discovered. A substance is generally made of atoms. There has been considerable research on atoms and their functioning, core, stability, and properties of emission and absorption of radiation. Special attention has been devoted to electromagnetic energy within an atom. Through these study approaches, possible explanation for quantization of atoms has been presented [1,2]. That is, the stable states of an atom occur only when two types of periodic processes are harmonized; one is the oscillation of electromagnetic energy in the atom, and the second is the rotational movement of the electron in the same atom.

Furthermore, it was found that the electromagnetic energy in an atom can be described using a transmission line, for example Lecher's line. An important constant was discovered in this way, the value of which depended only on the structure and parameters of the Lecher line and, in turn, the structure and parameters of the atom itself. Therefore, this constant is called the structural constant of the atom and denoted as s_0. Its value is obtained [3-9] by measuring, when it was found that lead ($_{82}$Pb) is the last stable element, and bismuth ($_{83}$Bi) is the first unstable element, and after the calculation of phase velocity of the electromagnetic wave in the atom [6]; then also in another way by calculation from data of National Institute of Standards and Technology U.S. Department of Commerce (NIST), https://www.nist.gov/pml/atomic-spectra-database (after you open this link, go to: Ground States&Ionization Energies; Spectra: H, Retrieve Data, the data is eV=13.59843449 eV, what from Eq. (82) in [8] gives $s_0 = \sqrt{1/\{2\sqrt{1-[1-eV/(mc^2)]^2}\}} = 8.278\,691\,910$, where e is the elementary charge, V is the ionization voltage, m is the mass of the electron, and c is the speed of light in vacuum). The structural constant s_0 is a non-dimensional fundamental constant. Thirteen other constants are derived from s_0 and from five other constants (i.e., c, e, m, proton mass m_p and Archimedes constant π). The thirteen constants, listed below, are redundant: the (1) fine-structure constant $\alpha = 1/(2s_0^2)$, (2) inverse fine-structure constant $1/\alpha = 2s_0^2$, (3) magnetic constant $\mu_0 = 4\pi \times 10^{-7} \cdot \mathrm{H/m}$ (redundant because of π), (4) electric constant $\varepsilon_0 = 1/(4\pi \times 10^{-7} c^2 \cdot \mathrm{H/m})$ (redundant because of π and c), (5) von Klitzing constant $R_K = \mu_0 c\, s_0^2$, (6) action (Planck's) constant $A_0 = \mu_0 c\, e^2 s_0^2$, (7) conversion constant $K_0 = 1/(2\mu_0 c\, e\, s_0^2)$, (8) ratio $e/A_0 = 2K_0 = 1/(\mu_0 c\, e\, s_0^2)$, (9) Josephson constant $K_J = 4K_0 = 2/(\mu_0 c\, e\, s_0^2)$, (10) Rydberg constant $R_\infty = m/(8\mu_0 e^2 s_0^6)$, (11) Bohr radius $a_0 = \mu_0 e^2 s_0^4/(\pi m)$, (12) Bohr magneton $\mu_B = \mu_0 c\, e^3 s_0^2/(4\pi m)$, and (13) nuclear magneton $\mu_N = \mu_0 c\, e^3 s_0^2/(4\pi m_p)$ [10]. Here I connect one more quantities with structural constant s_0, (14) boscovich $\mathrm{B} = 1/(2s_0^2)$; in the future it will show that maybe even (15) kelvin (K) is associated with the structural constant if somebody proves; the triple point of water is exactly $4s_0^2 \cdot \mathrm{K}$. Despite the redundancy of B it is suitable for the unit of *type of substance*.

Although the previous theoretical results are impressive, their applications need to be discussed.

The maximum speed at which an electron in the atom can move is limited on the speed of light, https://www.britannica.com/science/relativity. A previous study concluded that the velocity v of electrons increases with increasing atomic number Z [9], according to the relation $v/c = Z/(2n^{\pm 1} s_0^2)$, where n^{+1} or n^{-1} =1,2,3,…, depending on whether the orbits are farther or closer to the atomic nucleus (the reference point is $n^{\pm 1} = 1$). The question is, in the first orbit, at what value of Z_{max} will the electron reach the speed of light. Theoretically, for v=c and $n^{\pm 1}$ = 1, $Z_{max} = 2s_0^2$ [9]. It may not be an integer, because

Table 1. The proposed SI base units, including a new unit, boscovich*, B

Name of base quantity	Notation	Dimension	Unit	Unit symbol
Length	*l*	L	meter	m
Mass	*m*	M	kilogram	kg
Time	*t*	T	second	s
Electric current	*I*	I	ampere	A
Thermodynamic temperature	*T*	Θ	kelvin	K
Luminous intensity	I_v	J	candela	cd
Amount of substance	*n*	N	mole	mol
Type of substance**	*S****	N****	boscovich	B

**In honour of the precursor of atomic theory Roger Joseph Boscovich from the 18th century. **It is a proposition to introduce the type of substance as a new physical quantity. ***The sign S in honour of the English radiochemist Frederick Soddy (1877-1956), who discovered isotopic nuclides. ****Although the unit* mol *and the unit* boscovich *have the same dimension, i.e.,* N*, they are heterogeneous, and must not to be replacing by each other; these two units are mutually independent, because the counting (with unit* mol*) is different process than the sorting process (with unit* boscovich)

the structural constant s_0 comes from a continuous rather than a discrete theory.

Therefore, all elements of the periodic table must be between zero and Z_{max}. If Soddy's number of substance needs to be measured, then the measuring unit imposes itself through the following analogy. That is, if there are for example *N* equidistant points on any line *l*, the distance between two adjacent points is l/N [m]. Likewise, if in any given time *t*, *N* events occur evenly then the time interval between two adjacent events is equal to t/N [s]. In fact, if the entire periodic table, i.e., 100% of all elements, which can be represented by number 1, contains in terms of their classification Z_{max} equal elements, the "*numerical distance*" of these elements is equal $1/Z_{max}$. Since the choice of the unit is arbitrary, this "*numerical distance*" we choose as a unit of the physical quantity the *type of substance*. Therefore, $1/Z_{max} = 1/(2s_0^2)$ $=$ boscovich $=$ B $=$ 0.007 295 357 2330 is valid.

Each physical quantity, listed in above Table 1, is visualized and evaluated by a common method. Therefore, each quantity has its own name, notation, dimension, unit, and unit symbol. Without expressing measurement uncertainty, each quantity is expressed using its own notation, numerical value, and unit. For example, the current passing through a heater is *I* = 4.35 A, where *I* is the notation of the physical quantity of *electric current*, 4.35 is the *numerical value* of this quantity expressed in the unit "ampere", A; it will heat the room to a *thermodynamic temperature* of *T* = 293.16 K.

The aim of this work is to determine, by introducing a new unit, a way of expressing all substances in nature in the same way as with any other physical quantity.

For this purpose, a factor *f* is introduced such that the *numerical value* of any substance is expressed as a function *f*(***p***,***n***,***e***): *S* = *f*(***p***,***n***,***e***) [B], where ***p***, ***n***, and ***e*** are the numbers of protons, neutrons and electrons in the substance, respectively. The function *f*, therefore, represents the *numerical value* of the physical quantity *type of substance* expressed in the unit "boscovich", B.

2. METHODOLOGY

2.1 Description of Physical Properties of the Substance

To achieve the aim of this study, a mixed concepts is considered, which includes the concepts of both nuclear physics (isotopes, protons) and chemistry (ions, molecules and compounds). Substance is the real physical matter that constitutes a living organism or a non-living thing. The following substances are considered in this study:

(1) A vacuum (a space empty of matter, which has no substance or all substances are removed),
(2) A particle (including electron, proton, and neutron),

(3) An element (the basic substance that cannot be simplified further; hydrogen, oxygen, etc.),
(4) An atom (the smallest unit of an element, having all the characteristics of that element and consisting of a very small and dense central nucleus containing protons and neutrons, around which one or more electrons orbit; atoms remain undivided in chemical reactions except for the donation, acceptance, or exchange of valence electrons),
(5) A nuclide (which may be isotopic nuclides, with the same atomic number *Z*; isobaric nuclides, with the same mass number *M;* or isotonic nuclides, with the same difference between the mass number and the atomic number, *M* − *Z*),
(6) A molecule (whose properties vary from its constituent atomic parts),
(7) A compound (a molecule that contains more than one element), and
(8) An ion (an element, atom, nuclide, molecule, or compound in which the total number of electrons is not equal to the total number of protons, giving a net positive or negative electrical charge to the ion).

So, I determined the quantity called *type of substance*, and denoted it as *S*, in honour of the English radiochemist Frederick Soddy (1877–1956), who discovered isotopic nuclides.

The physical properties of the quantity *type of substance* are described in terms of mainly three parts: a *proton part* (the number of protons in the nucleus of an atom, *Z* or *p*); a *neutron part* (the number of neutrons in the nucleus, *n*), and an *electron part* (the number of electrons in the atomic shell, *e*). Other parts are also possible when the uniqueness of the mark needs to be ensured, so not to repeat two or more identical Soddy's numbers, for example by using a *distinguishing number* in the part denoted within Eq. (1) with *D*.

2.2 Capacity of the Quantity the *Type of Substance*

To determine the capacity of the quantity (that is, the largest amount or number that the quantity can hold), we first find the highest possible atomic number in the periodic table of elements. According to literature [1-10], the highest atomic number Z_{max} is $2s_0^2$, where s_0 is the structural constant of the atom; s_0 = 8.278 691 910, which results in $Z_{max} = 2s_0^2$ = 137.0734794824. It is related to the fact that no element can form if its electron travels in the first orbit faster than the speed of light. Without the first orbit, it is not possible to form the rest, even the atom itself.

If we include 1000 positions for the neutrons within the *neutron part*, then the capacity of the *type of substance* is $Z_{max} \times 10^3$. The number 10^3 = 1000 is chosen because not only is it easier to count and remember but also practical as it covers all the existing elements. If, for heavy elements, the limit of 1000 neutrons was exceeded, then the system would shift to a larger number, say 10^4, and again everything else in the approach remains unchanged.

If we additionally include 1000 more positions for the electrons within the *part belonging to the electrons*, then the capacity of the *type of substance* is $Z_{max} \times 10^3 \times 10^3$ = 137,073,479.4824 positions. The reason for considering 1000 positions of electrons is the same as mentioned above for the neutrons.

For molecules and compounds, this number will be much larger. The present concept has no theoretical limitations on the number of positions it may contain.

The periodic table is basically built on protons (***p***). It covers about a hundred different positions (maximum $2s_0^2 \approx 137$). Here, therefore, we discuss two properties, namely, *category* (i.e., protons, neutrons, and electrons) and the *number* of different positions (137, 1000, 10^4, 10^5, or million, and so further). Consider a system that consists of the two components, i.e., the *category* and the *number of positions*; for example *S* [(***p***, ***n***, ***e***), $10^3 \times 10^3 \times 10^3$] = *S*(3,$10^9$), which means that the system embraces three particles (protons, neutrons, electrons) and has 10^9 positions. In the initial version of the approach discussed here, we only considered protons and neutrons in a system [8, 9]. Theoretically, such a system covers (10^3x10^3)=10^6 positions and is described as the system *S*(2,10^6), as explained above. Later, in addition to the protons and neutrons, we introduced electrons. The system then moved from category 2 to category 3, e.g., *S*(3,10^9) [10]. With 1000 positions for each of the particles, the theoretical amount is $10^3 \times 10^3 \times 10^3 = 10^9$ (one billion) positions. By the same principle, it is possible to keep the same category of system and increase the number of positions for each particle from 10^3 to 10^4. Thus, we obtain the system $S(3,10^{12})$ in which we follow protons, neutrons and electrons, and include $10^4 \times 10^4 \times 10^4 = 10^{12}$ positions. If we include any additional particle or property, the system category changes and the number of positions is maintained or increased, thereby obtaining the system $S(4,10^{12})$ or $S(4,10^{16})$. Fig. 1, e.g., was created with the help of $S(3,10^9)$ system, and Table 2 based on system $S(4,10^{16})$, i.e., three particles (***p***, ***n***, ***e***), and one property (*distinguishing number*). In any case, the system is built so as to never transmit the numbers from one part to another, for example, from the electron part to the neutron part.

2.3 Dimension and Unit of the *Type of Substance*

A dimension of the *type of substance* is "one"; it is therefore a dimensionless quantity. The choice of the unit as usual can be made arbitrarily. As previously described for the unit, it is convenient to choose $1/Z_{max}$. This unit represents the "*numerical distance*" of two neighbouring atoms in the periodic table of elements. That unit we call boscovich, B, is in honour of Roger Joseph Boscovich [Croatian: Rudjer Josip Bošković, born on May 18, 1711, in Dubrovnik, Republic of Ragusa (modern-day Croatia); died on February 13, 1787, in Milan, Duchy of Milan (modern-day Italy)]. He was a precursor of atomistic science in the eighteenth century. Here, $1\ B = 1/Z_{max} = 1/137.07347948240 = 7.2953572330 \times 10^{-3}$. This is actually a *fine-structure constant*, α i.e., the unit $B = \alpha$. Boscovich, in his book *A Theory of Natural Philosophy* (first edition, Vienna, 1758), first used the term the *type of substance*, referring to the various substantial forms (for example: "…different substantial forms for different species", page 97, point 106, https://archive.org/details/theoryofnaturalp00boscrich) [11,12].

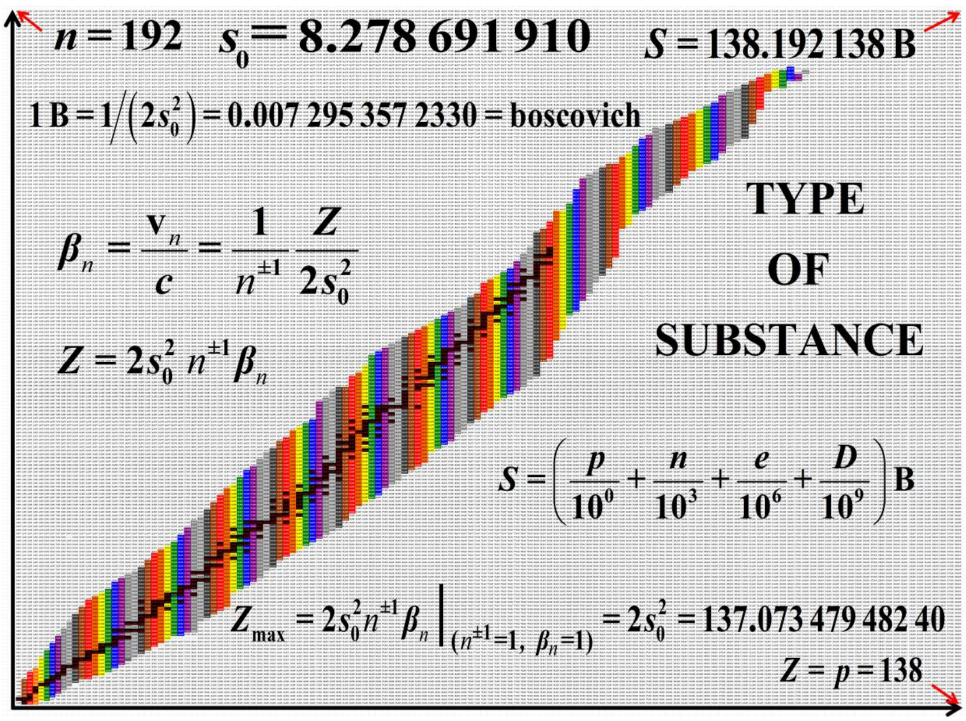

Fig. 1. *Type of substance* shown in the case of all (presently) known nuclides (more than 3180, coloured). Soddy's number of the substance, *S*, is calculated using Equation (1), depending on the number of protons (*p*, abscissa), neutrons (*n*), and electrons (*e*). Soddy's number is then divided by boscovich unit, B, and *S*/B is entered in a place corresponding to the number of neutrons (ordinate). Only black positions represent stable nuclides. https://en.wikipedia.org/wiki/Table_of_nuclides, http://periodictable.com/Isotopes/001.1/index.html

Table 2. Soddy's number *S* for several elements, nuclides, and compounds. Each element, atom, nuclide, molecule, or compound, as complex as it may be, can thus be processed and displayed by Soddy's number *S*, or the *f* =*S*/B value, as shown in this table; $f = p/10^0 + n/10^4 + e/10^8 + D/10^{12}$; $D = \sum_{i=1}^{N} i\, n_i$, *N* is the number of different entities (for elements is always *N*=1, for compounds, e.g., H_2SO_4 *N*=3 (H, S, O), the number of identical entities should also be taken into account (H×2, O×4); B = 0.0072953572330

Substance & formula	Elements	*p*	*n*	*e*	*f* (*p*, *n*, *e*) = *S*/B
Vacuum*	^{0}Vaccum**	0	0	0	0.0000 0000 0000
Electron	^{0}e	0	0	1	0.0000 0001 0000
Neutron	^{1}n	0	1	0	0.0001 0000 0001
Proton	^{1}p	1	0	0	1.0000 0000 0000
Hydrogen (protium)	^{1}H	1	0	1	1.0000 0001 0000
Hydrogen (deuterium)	^{2}H = ^{2}D	1	1	1	1.0001 0001 0001
Hydrogen (tritium)	^{3}H = ^{3}T	1	2	1	1.0002 0001 0002
Helium	^{4}He	2	2	2	2.0002 0002 0002
Carbon	^{12}C	6	6	6	6.0006 0006 0006
Carbon	^{14}C	6	8	6	6.0008 0006 0008
Nitrogen	^{14}N	7	7	7	7.0007 0007 0007
Oxygen	^{16}O	8	8	8	8.0008 0008 0008
Silicon	^{28}Si	14	14	14	14.0014 0014 0014
Phosphorus	^{31}P	15	16	15	15.0016 0015 0016
Sulphur	^{32}S	16	16	16	16.0016 0016 0016
Chlorine	^{35}Cl	17	18	17	17.0018 0017 0018
Iron	^{56}Fe	26	30	26	26.0030 0026 0030
Silver	^{107}Ag	47	60	47	47.0060 0047 0060
Thulium	^{169}Tm	69	100	69	69.0100 0069 0100
Iridium	^{193}Ir	77	116	77	77.0116 0077 0116
Platinum	^{195}Pt	78	117	78	78.0117 0078 0117
Gold	^{197}Au	79	118	79	79.0118 0079 0118
Mercury	^{202}Hg	80	122	80	80.0122 0080 0122
Lead	^{208}Pb	82	126	82	82.0126 0082 0126
Uranium	^{238}U	92	146	92	92.0146 0092 0146
Plutonium	^{244}Pu	94	150	94	94.0150 0094 0150
Oganesson	^{293}Og	118	175	118	118.0175 0118 0175
Oganesson (triple ionized)	^{293}Og	118	175	115	118.0175 0115 0175
The largest element, theor.	^{325}Xx, name unknown	137	188	137	137.0188 0137 0188
Water, H_2O	^{1}H, ^{16}O	10	8	10	10.0008 0010 0016
Heavy water D_2O	^{2}D, ^{16}O	10	10	10	10.0010 0010 0018
Carbon dioxide, CO_2	^{14}C, ^{15}O	22	22	22	22.0022 0022 0036
Carbon dioxide, CO_2	^{12}C, ^{16}O	22	22	22	22.0022 0022 0038
Sulfuric acid, H_2SO_4	^{1}H, ^{32}S, ^{16}O	50	48	50	50.0048 0050 0128
Sulfuric acid, H_2SO_4	^{1}H, ^{34}S, ^{16}O	50	50	50	50.0050 0050 0132
Propane, C_3H_8	^{12}C, ^{1}H	26	18	26	26.0018 0026 0018
Butane, C_4H_{10}	^{12}C, ^{1}H	34	24	34	34.0024 0034 0024
Ethyl alcohol, C_2H_6O	^{12}C, ^{1}H, ^{16}O	26	20	26	26.0020 0020 0036
Glucose, $C_6H_{12}O$	^{12}C, ^{1}H, ^{16}O	56	44	56	56.0044 0056 0060
Sucrose, $C_{12}H_{22}O_{11}$	^{12}C, ^{1}H, ^{16}O	182	160	182	182.0160 0182 0336
Carbamic acid, NH_2COOH	^{14}N, ^{1}H, ^{12}C, ^{16}O, ^{18}O, ^{2}H	32	32	32	32.0032 0032 0113
Adenine, $C_5H_5N_5$	^{12}C, ^{1}H, ^{14}N	70	65	70	70.0065 0070 0135
Guanine, $C_5H_5N_5O$	^{12}C, ^{1}H, ^{14}N, ^{16}O	78	73	78	78.0073 0078 0167
Glutamine, $C_5H_{10}N_2O_3$	^{12}C, ^{1}H, ^{14}N, ^{16}O	78	68	78	78.0068 0078 0168
Chlorophyll, $C_{55}H_{72}O_5N_4Mg$	^{12}C, ^{1}H, ^{16}O, ^{14}N, ^{24}Mg	482	410	482	482.0410 0482 0622

A vacuum does not have its official abbreviated tag. Mass number (the total number of protons and neutrons, **p**+**n**) is up-left; for example **p**=6, **n**=8, ^{14}C*

Accordingly, Soddy's number is calculated formulas follows:

$$S = \left(\frac{\boldsymbol{p}}{10^0} + \frac{\boldsymbol{n}}{10^4} + \frac{\boldsymbol{e}}{10^8} + \frac{\boldsymbol{D}}{10^{12}} \right) \mathrm{B} = \frac{10^{12}\boldsymbol{p} + 10^8\boldsymbol{n} + 10^4\boldsymbol{e} + \boldsymbol{D}}{10^{12}} \mathrm{B}, \quad (1)$$

S is a sign of a physical quantity the *type of substance*, which we call Soddy's number; B is the unit boscovich; $\boldsymbol{p} = \sum_{i=1}^{N} \boldsymbol{p}_i$, $\boldsymbol{n} = \sum_{i=1}^{N} \boldsymbol{n}_i$, $\boldsymbol{e} = \sum_{i=1}^{N} \boldsymbol{e}_i$ are the sums of all protons, neutrons and electrons, respectively, in the observed cases; and $\boldsymbol{D} = \sum_{i=1}^{N} i\,\boldsymbol{n}_i$ is a *distinguishing number*, i.e., a mathematical construct, introduced here to distinguish Soddy's numbers in the case of the same number of protons, neutrons and electrons in different molecules, compounds, or ions. *D* can be formed with the same purpose in many different ways, and *N* is the number of different entities (vacuum, particles, elements, atoms, nuclides, molecules, compounds, or ions) involved in the observed case.

All so far said is equally valid for antimatter, with the conditions $\boldsymbol{p}=|\pm\boldsymbol{p}|$, $\boldsymbol{n}=|\pm\boldsymbol{n}|$, $\boldsymbol{e}=|\pm e|$, and $\boldsymbol{D}=|\pm\boldsymbol{D}|$. With antimatter, the number of elements is doubled (for matter is $2s_0^2$, for antimatter it is also $2s_0^2$, i.e., total is $4s_0^2$ = 274.15), whereas the radiation (thermodynamics) does not differ. This means that the number of sources of radiation is doubled in relation to the matter. According to https://www.britannica.com/science/kelvin the triple point of water is 273.16 K.

This number, 273.16, compared to $4s_0^2$ = 274.15 differs by 0.36%. This resemblance of two numbers deserves to be explored in the future.

The factors 10^4, 10^8 and 10^{12} in Eq. (1) may be different, which is primarily dependent on the fact that transference of numbers from one part to another is not permissible, for example, from the electron part to the neutron part.

3. RESULTS AND DISCUSSION

Within the periodic table, more than 137 million different positions of the physical quantity, *type of substance*, is not expected from practical viewpoint. Theoretical restriction, however, does not exist. For different molecules and compounds, this number is not limited, both theoretically and practically. All the positions of the *type of substance* can be calculated using Eq. (1), and some of the results are shown in Fig. 1 and Table 2.

Fig. 1 show all the elements of the periodic table of elements and their nuclides, while Table 2 contains Soddy's numbers for some elements, nuclides, molecules, and compounds.

In this way, any substance can be evaluated and described in terms of *type of substance* as with any other measurable quantity. The *type of substance* thus becomes a new physical quantity with the unit boscovich. For now this unit is only a proposal (see Table 1).

4. CONCLUSION

Research on atoms and knowledge of the maximum atomic number, induced the introduction of the *type of substance* as a new physical quantity; its unit is boscovich, B, and is given by fraction $1/Z_{\max}$ of the mathematically highest atomic number $Z_{\max} = 2s_0^2$ = 137.0734794824; therefore, B = 0.0072953572330. This allows all existing substances (ranging from vacuum, elemental particles, chemical elements, nuclides, molecules, compounds, to ions) to be expressed as with any other physical quantity. It means any value of a physical quantity is expressed as a comparison to a unit of that quantity. In our case, the physical quantity *type of substance S* is expressed as the product of a numerical factor *f* and unit boscovich, B; $S = f\cdot$ B. Factor *f* represents the *numerical value* of the physical quantity *type of substance*, it is the function $f(\boldsymbol{p},\boldsymbol{n},\boldsymbol{e}) = \boldsymbol{p}/10^0+\boldsymbol{n}/10^4+\boldsymbol{e}/10^8+\boldsymbol{D}/10^{12}$, where $\boldsymbol{p}$, $\boldsymbol{n}$, and $\boldsymbol{e}$ are the numbers of protons, neutrons, and electrons in the observed substance, respectively, and $\boldsymbol{D}$ is a *distinguishing number*, i.e., a mathematical construct, introduced here to distinguish Soddy's numbers *S* in the case of the same number of protons, neutrons, and electrons in different molecules, compounds, or ions. The number $\boldsymbol{D}$ can be formed in several different ways, and here one of them is shown. The factors 10^4, 10^8 or 10^{12} in the previous function may be different if it is needed, primarily to avoid transference between parts of numbers belonging to electrons, neutrons or protons.

Since the unit boscovich cannot be expressed with the help of other seven basic units, a table with eight basic units is proposed; m, kg, s, A, K, cd, mol, and B.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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