# The Statistical Origin of the Spin

Antonio Fazzolari[1].

*revision 1*

**Abstract.**

*Following what already exposed in "The statistical origin of the Alpha constant[2]", a model based purely on statistical mechanics is proposed to explain and calculate with high accuracy the properties of the electron, like charge, spin and magnetic moment. All these features, beyond the very existence of the electromagnetic interaction, derive essentially from the assumption that a boson wave field possesses a chemical potential and from the definition of two statistical sets of opposite temperature. It's also shown that the SU(2) algebra, which is normally just assumed for the half Spin particles, is a consequence of this statistical structure, as it happens for the electric interaction. The only constants used are c, ħ and the Boltzmann constant. The model predicts also a light asymmetry between electric repulsion and attraction that could explain the origin of the weak interaction.*

## 1. Overview and Motivation

The reasons because of which a deep rethinking of the theoretical Physics is necessary have already been exposed in the precedent paper and will not be repeated in detail here. In synthesis, The Standard Model is not a true physical theory[3], but more a stratification of ad-hoc hypothesis based on free adjustable parameters which have been added over time to put a patch on precedent half-working assumptions[4]. There

1 Dottore in Fisica (2001 Florence University) Dr. Ing. (2005 TU Braunschweig).
2 There are some differences w.r.t. the precedent model, which lead to an overall enhanced effectiveness. Also, the origin of the repulsive interaction has been best explained. All the relevant arguments are repeated here.
3 Which should stem from few clear assumptions, as the General Relativity and the early Quantum Mechanics.
4 The first example of this approach has been the assuming the Spin as originating "by magic will" from the SU(2) group, as observed by Werner Heisenberg discussing with Wolfgang Pauli about his famous matrices. Despite being an advocate of an algebraic approach to QM, Heisenberg had clear in mind that invoking an algebraic rule alone does not solve a physical problem. - David C. Cassidy *Uncertainty. The Life and Science of Werner Heisenberg.* W.H. Freeman and Company, New York, 1992.

is nothing particularly wrong in such a construct, except the pretense of regarding it as fully or even partially successful in *explaining* the physical reality[5]. Moreover, at present day, even a satisfactory model for the simplest and lightest charged particle, the electron, does not exist[6], and some old problem are still unsolved, like the radiative friction and the interpretation of the "probability density" in the Schroedinger's equation. But also other fundamental questions are clearly unanswered and forgotten: Why the charge-mediated interaction exists? Why its value is exactly the same for all particles? Why the Spin's value is the same for all Fermions? Why particle and anti-particles pairs annihilate? These question are not philosophical, but legitimate physical arguments, if not more legitimate than other many secondary issues which many modern physicists have been busy discussing about[7].

The answer should be obvious also for the less skilled scientist: the charge, spin, mass and magnetic moment of some particle are immutably the same each time that such particle is created because *they obey some equation that forces them to that values.*

This paper is devoted to identify such equation for the electron and to test it with some high accuracy numerical predictions. Nevertheless, the model here presented is not complete, and should be viewed as a consolidated step towards a full and consistent Quantum Theory, which derives her intrinsic statistical nature from an underlying Statistical Mechanics, as suggested by Albert Einstein discussing with Erwin Schroedinger on his famous equation[8]. His concern, however, remained

5 Extremely rare and short lived particles, which can be spotted only after filtering enormous amounts of data, are not the best example of physical reality. So, let's start investigating the properties of simple and stable particles first.

6 *John D. Jackson – Classical Electrodynamics.* 2nd Edition. Chapter 17. In the 3rd edition, the affirmation has been smeared out, embracing the alleged success of the QED and of the Standard Model. The remark of the lacking of a satisfactory treatment of the radiative reaction force remains, as well as the admission of the total failure in explaining strong interaction forces.

7 Not in this place, but it would be very useful if sooner or later someone would calculate the amount of ink, man-hours and money spent in the discussion of pointless topics in theoretical Physics. One example: Quantum Gravity: the pedantic pretense of applying a flawed method (firmly rejected by A. Einstein) to a beautiful theory, no wonder that it failed. Flawed and dumb methods can be tricked to work just once or twice, while beautiful and well founded theories are known to give more and more confirmations.

8 Hopefully the very famous sentence " God does not play dices" does not require a bibliographic reference.

unattended and the origin of the statistical nature of Schroedinger equation has never been clarified, as well as the "point-likeness" of the electron. Modern physicists simply shelved this problem and many others as unsolvable and ignored them[9].

As noticed, *no free parameter and no constants other than c,* $\hbar, k_B$ has been introduced or adjusted to obtain the presented model's predictions. It's not superfluous to remember that a physical theory *must* rely on some initial *Ansaetze* and *should not* contain free parameters or ad hoc terms[10]. Again, this is not a philosophical problem, but a true scientifical issue, because it involves the relation between the theory and the experimental confirmation. If a model is admitted to have freely adjustable parameters, there is no way to define clearly if it fits the observations or not, and this rises an heavy doubt on his real utility. In this sense, the affirmation "The Standard Model is verified experimentally", is void of sense. The model is verified because it has been constructed in large part on experimentally given parameters, mainly a load of "coupling constants", "charges", "currents" and "vector particles". Just to recall one assumption, the strong interaction is supposed to be mediated by Gluons between Quarks, and by Mesons between Nucleons. This necessity to adjust the model by introducing new particles is the *typical methodological error of the Standard Model* and shows quite clearly that the comprehension of fundamental interactions is somewhere near to zero. Moreover, to state "an interaction exists because a particle of some mass carry it" and pretending to recreate such particle, after filtering million of events inside a collider, is the typical *circular reasoning that explains basically nothing* and

---

9 Even worse, to avoid to confront the fact that they cannot explain the nature of the Spin, they build up a mind-blocking frame of statements like the "Spin has no relation to rotation" and "the electron has no structure". This kind of dogmatic attitude is unluckily very common among physicists because it's rewarded in the apprentice phase, while independent thinking is discouraged, when not openly persecuted.

10 The Standard Model, is based on about 25 parameters. The "most advanced" QED calculations contain ad-hoc loop terms and freely adjusted renormalization constants. Conversely, Einstein's equation contains only one parameter (later removed) c and G and Schroedinger's equation contains only alpha, c, the electron mass and the Planck’s constant.

nevertheless has been sold as a big success of the Standard Model[11]. Following the established trend of inventing some ephemeral new particle to solve physical problems, in recent years we have seen also statements and media celebrations about the discovery of a "God's particle" that would be responsible of the mass of all particles, without actually allowing the calculation of any of them (maybe thus a quite liberal God). If took seriously, the inconsistency and lack of scientifical rigor of such *modus operandi* left speechless, especially coming from highly intelligent people who are used to give moral lessons to others, and drop a serious issue about the role and essence of the scientifical community[12]. These critical reflections are necessary to justify the need of a radical rewind of the approach to fundamental Physics, going back to more serious thinkers and to theories which have solid foundations, like the Statistical Mechanics, and to the founding principle of the Physics, that is, the assumption that at the root of everything there must be a reasonably simple equation, thing that the two-pages Lagrangian of the Standard Model is surely not[13].

Since the properties of the various particles, except the charge, are instead very different, there must be some process that generates this complexity from simple "bricks". The "bricks" will be in the following pages individuated as some sets of boson radiation, collectively normalized to 1, which allow to calculate the properties of the electron and disclose an explanation of how and why charge and spin are constant and deeply correlated properties of this particle.

## 2. The Statistical Model

To start, we assume the existence of some kind of bosonic wave field, without any other particular assumption, a part the standard quantum

11 See Alexander Unzicker "The Higgs Fake" Amazon pub. For a glass clear survey on the methodological flaws of the CERN discoveries like W and Z particles and the Higgs Boson.
12 As often in human things, beautiful names with high moral value hide a somehow rotten nature inside.
13 Other fundamental Physic's models, like the Superstrings, may have more elegant formulas, but their predictive power is even worse than the Standard Model, or totally absent.

statistics hypothesis. We assume the existence of waves of frequency $v$ and energy $hv$, in order to set up a quantum statistical ensemble based on the Bose-Einstein statistics. We also assume also the degeneracy for each energy state to be 2, and the presence of a chemical potential.

## 2.1 The Primal set

We define as *primal set* a set of plane waves quantized by null field (Dirichlet) boundary conditions in cartesian coordinates. In practice, this is no other than the well know black body distribution, with the addition of the chemical potential. The role of the chemical potential is fundamental in the following develop of the model. Obviously, here it has nothing to do with chemistry, but rather it has the function of representing the energetic cost of adding a particle to the statistical set and it's the parameter that controls the diffusion between sets. According to standard statistics, in presence of this quantity that is usually indicated with μ, the population of an energy level, is:

(1)
$$N_i = \frac{2}{e^{(\epsilon_i - \mu)\beta} - 1}$$

being β=1/kT (as usual, T is the temperature of the system at equilibrium, k the Boltzmann constant). Making use of the discrete-to-continuous approximation, the total number of particles becomes:

(2)
$$N = \frac{8\pi V}{h^3 c^3} \int_0^\infty \frac{\epsilon^2}{e^{(\epsilon - \mu)\beta} - 1} d\epsilon$$

By evaluating integral in (2) we get:

(3)
$$N = \frac{16\pi V}{c^3 h^3 \beta^3} Polylog(3, e^{\beta\mu})$$

where we assumed βμ <0. In the same way, we can evaluate the total energy of the system:

(4)
$$E = \frac{8\pi V}{h^3 c^3} \int_0^\infty \epsilon^3 d \frac{\epsilon}{e^{(\epsilon - \mu)\beta} - 1} = \frac{48\pi V}{c^3 h^3 \beta^4} Polylog(4, e^{\beta\mu})$$

and the mechanical work done by the system, know as PV. For discrete levels, it gives the integral:

(5) $$PV=-\frac{8\pi V}{\beta h^3 c^3}\int_0^\infty \epsilon^2 \log\left(1-e^{(-\epsilon+\mu)\beta}\right) d\epsilon$$

By evaluating the integral in (5) (dropping all the terms at infinite) we get:

(6) $$PV=E/3$$

All these quantities depends on two parameters: the temperature T (trough β), and the chemical potential μ. While the role of the temperature is of quite easy interpretation as an indicator of the amount of energy present into the system, the nature of the chemical potential is a little more elusive. Its definition stems from its role of Lagrange multiplier with the respect to the constraint of N=const in the Microcanonical Ensemble and there are several thermodynamical relations that links it to other quantities which attain a maximum or a minimum when the system is at equilibrium. If the quantity considered is the Entropy S, which reaches a maximum at equilibrium, the following thermodynamical relation holds[14] :

(7) $$-\frac{\mu}{T}=\left(\frac{\partial S}{\partial N}\right)_{E,V}$$

Here S, N, E are obtained from the integration over a continuum of states, as in (3), (4) and (5) and are assumed to be differentiable functions of (μ,T). By substituting the definition for the entropy in the Canonical Ensemble S=(E+PV)/kT[15] into (7) and doing some algebra we get:

(8) $$-\frac{\mu}{T}=(E+PV)\left(\frac{-1}{T^2}\right)\left(\frac{\partial T}{\partial N}\right)_{E,V}+\left(\frac{1}{T}\right)\left(\frac{\partial PV}{\partial N}\right)_{E,V}$$

---

14 Ralph Baierlein, *"The elusive chemical potential,"* Am. J. Phys. 69, 423–434 (2001). The author indicated this formula also as *definition* of chemical potential, while S is given by its Canonical Ensemble form.

15 To avoid confusion, with S will be always indicated the Entropy in the Canonical Ensemble form, without the contribution from the chemical potential -μN/kT. Also, to keep the results readable and the notation compact, S will be evaluated as a pure number, while T will be every time multiplied by the Boltzmann constant k.

where we dropped the term $(\frac{\partial E}{\partial N})_{E,V}$ since it is 0. We multiply now eq. (9) for $(\frac{\partial N}{\partial T})_{E,V}$, since for a given quantity A holds $(\frac{\partial A}{\partial N})_{E,V}(\frac{\partial N}{\partial T})_{E,V}=(\frac{\partial A}{\partial T})_{E,V}$, it follows the equation:

(9) $$-\mu(\frac{\partial N}{\partial T})_{E,V}=\frac{-(E+PV)}{T}+(\frac{\partial PV}{\partial T})_{E,V}$$

The constancy of V during the differentiation is easily treated, since it does not depends on the primitive variables (T,μ), so we can let everywhere fall the $()_V$ subscript. We get:

(10) $$-\mu(\frac{\partial N}{\partial T})_{E}=\frac{-(E+PV)}{T}+(\frac{\partial PV}{\partial T})_{E}$$

In the terms $(\frac{\partial N}{\partial T})_{E}$ and $(\frac{\partial PV}{\partial T})_{E}$ it must now be managed the constrained differentiation. The constancy of E must be enforced by projecting the gradient of N(T,μ) onto the E(T,μ)=const direction. The direction E(T,μ)=const is by definition orthogonal to $\nabla E$ and thus is given by:

(11) $$\nabla(E)\perp=(\partial_\mu E,-\partial_T E)$$

The projection gives:

(12) $$(\nabla N)_E=\frac{(\nabla N\circ\nabla(E)\perp)}{|\nabla(E)\perp|^2}\nabla(E)\perp=\frac{(\partial_T N\,\partial_\mu E-\partial_\mu N\,\partial_T E)}{((\partial_\mu E)^2+(\partial_T E)^2)}(\partial_\mu E,-\partial_T E)$$

dividing by $\partial_\mu E^2$ and dropping quadratic terms one gets:

(13) $$(\partial_T N-\partial_\mu N\frac{(\partial_\mu E)}{(\partial_T E)},-\partial_T N\frac{(\partial_T E)}{(\partial_\mu E)})$$

The first component of the constrained gradient (13) can be used as expression of $(\frac{\partial N}{\partial T})_{E}$. Putting all terms into (10), changing sign and observing that the term $(\frac{\partial PV}{\partial T})_{E}$ is easily evaluated as null, since PV=E/3, one gets:

(14) $$\mu(\partial_T N-\partial_\mu N\frac{(\partial_\mu E)}{(\partial_T E)})-(4/3E)=0$$

Using the expressions (3) and (4) for E and N, this equation is easy to solve since it depends only on the quantity C=βμ. Thus, it appears that the definition of chemical potential for the system considered is compatible only with certain values of β and μ related by some constant C. Before to examine the solution, it is necessary to consider some additional terms which are part of the statistical set. The integrals in (2) and (4) cover all the radiation modes present in the black body, except a term that is obtained by the limit $\epsilon \to 0$.This object can be defined as the 0-energy level, which nowadays posses a non zero population:

(15) $$N_0=\frac{2}{e^{-\beta\mu}-1}$$

and a non zero mechanical work.

(16) $$PV_0=kT\,2\log(1+\frac{1}{e^{(-\beta\mu)}-1})$$

Since this 0-energy level does not affect the energy balance, the constrained derivatives of eq. (10) simplify to normal derivatives. Adding them to left side of eq. (14) one gets;

(17) $$\mu(\partial_T N-\partial_\mu N\frac{(\partial_\mu E)}{(\partial_T E)})-(4/3E)+(\frac{\partial N_0}{\partial T})+\frac{(PV_0)}{T}-(\frac{\partial PV_0}{\partial T})=0$$

Which represents the definition of chemical potential applied to whole the statistical set. Having collected the terms from the "standard" blackbody plus the terms from the 0-energy level, we can now turn to the solution of the equation. In order to solve eq. (17), an additional equation is needed, to get rid of the volume term $\frac{8\pi V}{h^3c^3}$which appears in all terms of (14). The most simple option is to impose to the total number of particle $N+N_0$ to be constant, coherently with the Canonical Ensemble form we adopted for S. As value for the particle number, one could assume 1 as the obvious choice, but it turns out that the value ¼ works much better to calculate a value of the alpha constant. This is equivalent of assuming that the field is 4-dimensional, so that a single particle “entering” the field is shared between 4 identical sub-fields normalized to ¼ each. By Imposing $N+N_0=1/4$ we get:

(18) $$\frac{16\pi V}{c^3 h^3 \beta^3} Polylog(3, e^C) + \frac{2}{e^{-C}-1} = \frac{1}{4}$$

which gives:

(19) $$\frac{16\pi V}{c^3 h^3 \beta^3} = \frac{(\frac{1}{4} - \frac{2}{e^{-C}-1})}{Polylog(3, e^C)}$$

by substituting (18) into (4) we get an expression for E which depends only on C:

(20) $$E = \frac{48\pi V}{c^3 h^3 \beta^4} Polylog(4, e^{\beta\mu}) = 3\frac{(\frac{1}{4} - \frac{2}{e^{-C}-1})}{Polylog(3, e^C)} Polylog(4, e^{\beta\mu}) kT$$

and in similar way for PV:

(21) $$PV = E/3 = \frac{(\frac{1}{4} - \frac{2}{e^{-C}-1})}{Polylog(3, e^C)} Polylog(4, e^{\beta\mu}) kT$$

The derivatives of E and N with respect to T and μ are now straightforward to calculate, and also the T derivatives of $N_0$ and $PV_0$. Putting all the terms into eq. (17) we get an equation in C which can be easily solved numerically:

(22) $$8\, polylog(4, e^C) + \frac{(4C^2 polylog(3, e^C))}{((e^{-C}-1)^2 e^C (\frac{1}{4} - \frac{2}{(e^{-C}-1)}))} - 6\, C polylog(3, e^C) + \frac{(8\, C polylog(2, e^C)\, polylog(4, e^C))}{(polylog(3, e^C))} + \frac{(4\, polylog(3, e^C)\, C\, e^C)}{(\frac{1}{4} - \frac{2}{(e^{-C}-1)})}(1 - e^C) = 0$$

Performing the calculation with 20 digits accuracy, the solution is:

(23) $$C = -5.0868580117334065176$$

The assumed constancy of C can be interpreted in the following way.

If we substitutes expressions for energy and PV eq. (4), (6) into the definition of entropy S=(E+PV)/kT, we see that the assumption βμ=C=const is equivalent to S=const, defining in fact and adiabatic transformation.

To summarize what has been done until now, we showed that a set of black body radiation of a massless 2 times degenerate bosonic wave field with a chemical potential shows a relation βμ=C, being C the solution (22) of the definition of chemical potential, eq. (7). If the system is altered, e.g. by varying the volume, the temperature T of this radiation can vary, while the chemical potential must follow the variation of T to keep S constant. The value of C, and thus the value $N_0$ of the 0-energy level population, are constants of the model. This equation and its solution define what we can call the *primal set of radiation.* Now we will try to examine what happens if a set of radiation (defined within a spherical geometry) is assumed to be at diffusive equilibrium with the primal one. This condition is assured by imposing βμ=C to take the same in value for both sets[16]. With the calculation of the C value, the hardcore physics part is done, and the rest of the job is essentially just finding a combination of spherical radiation sets that conserves the particles' number. Such combination will be responsible of the properties of the particles, like charge, spin, magnetic moment and mass.

## 2.2 The spherical set of radiation modes.

If we look for the solution of the scalar wave equation (Helmholtz equation) in spherical coordinates, we find:

(24) $$u(r,\theta,\phi)=N\sqrt{\frac{2}{\pi}}k\left\{\begin{matrix}J_l(kr)\\N_l(kr)\end{matrix}\right\}P_l^m(\cos(\theta))\left\{\begin{matrix}\sin(m\phi)\\\cos(m\phi)\end{matrix}\right\}$$

where $P_l^m$ is a Legendre polynomial, and $J_l$ and $N_l$ are the spherical Bessel and Neumann functions, and N is a normalization factor. The radiation

16 Consistently with the definition (7) for chemical potential. See also formula (3) in Ralph Baierlein, *"The elusive chemical potential,"* Am. J. Phys. 69, 423–434 (2001).

modes allowed by the presence of the boundary condition on a boundary point, which is distant *a* from the origin, are fixed by equation:

(25) $$J_l(ka)=0$$

which has solutions with respect the wave number k:

(26) $$k_{l,n}=\frac{BesselJzeros(l+1/2,n)}{a}$$

We assume the N is tuned in a way that spherical radiation modes are normalized to 1/3[17], so this factor will enter in every particle counting involving spherical radiation. It follows that energy of a spherical mode is given by the usual value hν, which holds for plane waves, corrected by a factor 1/3 and multiplied by 2 for the degeneracy of the modes. We get:

(27) $$\epsilon_{l,n}=\frac{2}{3}\frac{BesselJzeros(l+1/2,n)}{a}\frac{hc}{2\pi}$$

Of all the solutions, we consider (l=1, n=1) as base brick for the interaction set. Starting from the $k_{1,1}$ level, it is then possible to build an entire class of new energy levels, which will give body to the statistical set. These levels are are obtained when a particle populates two or more spatially contiguous levels *one after the other*[18]. To build such a "conditioned chain", we need to connect the origin with the point r=a trough n equal segments of length a/n, each containing the same oscillation mode, as shown in Figure 1.

17 This normalization may have some more deep physical reason, not evident at the moment.

18 This possibility, although real, seems not much considered in standard Statistical Mechanics. But at equilibrium, particles are continuously jumping from one level to another, so this kind of "secondary" level is a well-defined physical object consistent with boundary conditions.

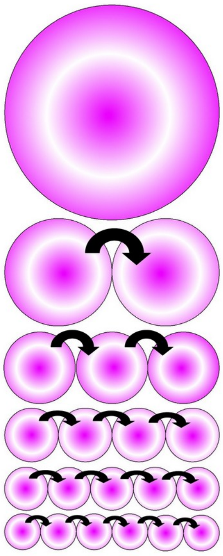



***Figure 1. Levels in the conditioned chain.***

In such scheme, the population of the level 112 is assumed to be $N_{11}^2$ , consistently with the Bayes formula for *conditioned probability*[19]. Starting with $k_{1,1}$ level, which has population:

(28)
$$N_{11} = \frac{2}{e^{\beta \epsilon_{11} - C} - 1}$$

we obtain a new member of the statistical set, which has energy and population, while the other quantities are defined in the usual way. By applying recursively this process, we get the new levels:

(29)
$$N_{112} = \left(\frac{2}{e^{\beta(2\epsilon_{11}) - C} - 1}\right)^2$$
$$N_{113} = \left(\frac{2}{e^{\beta(3\epsilon_{11}) - C} - 1}\right)^3$$
$$N_{114} = \left(\frac{2}{e^{\beta(4\epsilon_{11}) - C} - 1}\right)^4$$
$$N_{115} = \left(\frac{2}{e^{\beta(5\epsilon_{11}) - C} - 1}\right)^5$$
$$N_{116} = \left(\frac{2}{e^{\beta(6\epsilon_{11}) - C} - 1}\right)^6$$

Some observations are necessary:

1) The recursion is arrested to $6^{th}$ member. Since in general terms $N_{11N}$ are not small, this is an arbitrary choice that will be justified better later

19 The bibliographic reference is left as exercise to the reader.

on.

2) For sufficient large negative β, we will have to deal with negative populations. This is anything of particularly strange, since it is possible to postulate, along with bosons, a population of anti-bosons, characterized by a negative N, being all the remaining features identical. An anti-boson could be view as an oscillation mode populated by radiation in anti-phase with respect to a “normal” one. A statistical set can contain both kinds of radiation, but not within the same energy level, since the populations sum to zero.

3) to avoid imaginary entropy, the entropy associated with a negative population $N_{11x}$ must include an absolute value.

Each of these new levels has associated a 0-energy level, which is obtained applying $\epsilon \to 0$ to the $N_{11x}$ and has a numerical value, depending only from C already calculated in (23):

(30)
$$\begin{gathered} N_0 = 0.012431592386209409451 \\ N_{02} = N_0^2 = 0.00015454448925685975887 \\ N_{03} = N_0^3 = 0.0000019212340959761 9965 \\ N_{04} = N_0^4 = 2.3883999159663641424 \cdot 10^{(-8)} \\ N_{05} = N_0^5 = 2.9691614210550645820 \cdot 10^{(-10)} \\ N_{06} = N_0^6 = 3.6911404515414851408 \cdot 10^{(-12)} \end{gathered}$$

From eq. (30), we can already calculate the potential terms that will give body to the electrostatic interaction, which is due to this N0 levels. The potential that fits better to the job is the kTS, which is one of the eight canonical thermodynamic potential, sometimes called $X_2$ potential, in the form taken within the Canonical Ensemble, so discounting the contribution from chemical potential. This potential is coincident with the classical mechanical work PV, and it's also associated with the so called *entropic force*. Remembering that for a level of population $N_i$ holds for the numerical entropy $S_{11x} = \log(1+N_{11x})$[20], one gets the 0-energy level

20 For a better readability, from now on the the Entropy will be defined as a pure number, and the Boltzmann k will be associated with the temperature T.

entropy terms:

$$S_0=\log\left(1+N_0\right)$$
$$S_{02}=\log\left(1+N_0^2\right)$$
$$S_{03}=\log\left(1+N_0^3\right) \quad (31)$$
$$S_{04}=\log\left(1+N_0^4\right)$$
$$S_{05}=\log\left(1+N_0^5\right)$$
$$S_{06}=\log\left(1+N_0^6\right)$$

The total entropic potential of the 0-energy level is obtained by multiplying the sum of $S_{0x}$ by the temperature kT, which is at present undefined. What we thus need is an equation of conservative kind that limits T to some values, in order to generate a 1/r dependence. This equation is the most obvious: the total particle number, which is 1, is conserved, while part of the population of the four original primal fields is shifted to spherical sets as described in the following chapter. But before of proceeding to the calculation of alpha, it's necessary to fix some simple additional rules that govern the population shift.

## 2.3 additional rules.

1) As stated before, the energy of a spherical level contains a factor 1/3 coming from the normalization of the wave-function. Beyond this, in every computation of the population that include spherical levels and non-spherical levels the spherical level's population must be normalized by 1/3.

2) N0 levels are obtained as limit from finite energy levels. The rule is that each finite energy level must have its own N0 level in the statistical set. If the population of the level is normalized (in practice, by the 1/3 factor for the spherical levels), the N0 inherits the normalization factor.

3) N0 levels can be signed.

4) If two spherical domains are in contact at a boundary, an extra secondary level is created from the union of two levels, as depicted in Figure 2. Indeed, if the levels N02 of two different spherical sets are

touching, by a simple geometrical effect, a third NO2 level is generated. Same holds for N03, where the new levels are 2, for N04 with 3 new levels, etc. This sort of "contact interaction" is of pure statistical origin and holds also for finite energy levels.

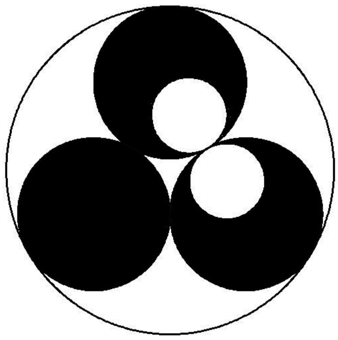


***Figure 2. Extra N02 level from contact interaction.***

## 3. Calculation of alpha.

Recalling that the primal set is made of four sub-fields filled with black body radiation (with chemical potential), each populated by ¼ of a boson[21], we suppose now that a given volume occupied by this single boson undergoes a *population shift* defined in the following way:

While one subfield is left unchanged, the other three sub-fields shift their population to two new objects respectively of negative and positive temperature, which are supposed to live in two different sub-fields:

1) The **negative temperature** object is composed by 4 spherical domains disposed in tetrahedral geometry, of which one is filled with a spherical radiation at negative temperature T and three are filled solely by a negative signed 0-energy level, $-N_0$.

2) The **positive temperature** object is composed by two spheres filled with radiation at positive temperature $\overline{T}=|T|$. These objects are arranged in the same tetrahedral geometry of the precedent sets, and are also enclosed by a bigger sphere filled with the primal radiation that did not

21 Or, making use of the Ergodic Theorem: the one boson passes 1/4 of the time in each subfield.

take part to population shift.

The first object is depicted in Figure 2. We will call it the **Spin-Charge Tetrahedron**, for the reason that this configuration is responsible of the value of the charge and of the spin of the particle, as we will see in next chapter.

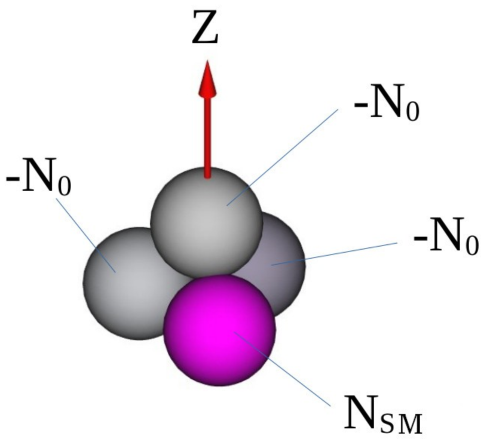



***Figure 2. The Spin-Charge tetrahedron with population's values.***

To write an equation for the population shift, first we have to correctly evaluate the population of this tetrahedron, which is the sum of the population of every single set, as defined in the precedent chapter, plus the "extra levels" that are originated by the contact of high order levels like N02, N03, etc.

The three gray spheres population results thus: -3N0-6N02-9N03-12N04

According the already defined rules, the population of the negative temperature spherical set (the purple ball) is $N_{SM}=(N_{11}+N_{112}+N_{113}+N_{114}+N_{115}+N_{116})/3$.

Then, it must be added a set $N_{SM0}$ which is associated with the $N_{11x}$ levels according the already discussed limit Ɛ→0 procedure.

(32) $$N_{SM0}=N0/3+N02/3+N03/3+N04/3+N05/3+N06/3$$

The total population for the Spin-Charge Tetrahedron is thus:

(33) $$N_{SPCTHET}=N_{SM}+N_{SM0}-3N0-6N02-9N03-12N04$$

Where $N_{SM}=(N_{11}+N_{112}+N_{113}+N_{114}+N_{115}+N_{116})/3$ are the populations of the negative T sphere and that of its 0-energy levels.

The positive temperature object, which occupies the second subfield, is supposed to share the same geometry of the negative one and is depicted in Figure 4 with the relative population's value.

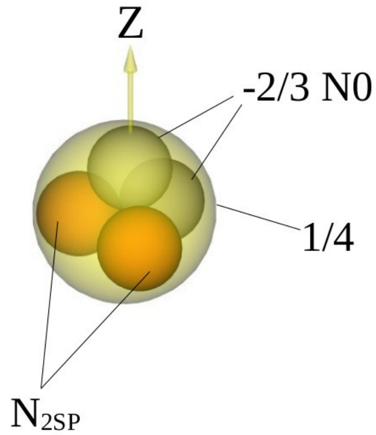



***Figure 4. The Static Tetrahedron with population's values.***

The geometry is identical with the Spin-Charge Tetrahedron, but here just two spheres are filled with positive temperature radiation, the "empty" two being populated instead with a -2/3 N0 and higher order terms. The tetrahedron is then **enclosed** by the sphere of primal radiation that did not take part to the population shift, (this fact will be relevant only later, for the calculation of the magnetic moment). Since this object does not contribute to Spin or Charge, but solely to particle mass, we can call it **Static Tetrahedron.** The population of the Static Tetrahedron is thus:

(34) $$N_{STATIC}=N_{2SP}+N_{2SP0}-\frac{2}{3}(N0+N02+N03+N03+N05+N06)+1/4$$

Being $N_{2SP}=(2N_{11}+3N_{112}+4N_{113}+5N_{114}+6N_{115}+7N_{116})/3$ and $N_{2SP0}=(2N0+3N02+4N03+5N04+...)/3$ the contributions of the two positive T spheres with their contact terms and N0 levels.

Since the total boson population is by hypothesis 1, holds the eq:

(35)
$$1 = N_{SPCTHET} + N_{STATIC}$$

To solve (35) it is convenient to define the adimensional variable $B = \frac{\hbar c}{r}\beta = \frac{\hbar c}{r}\frac{1}{kT}$. We will seek the solution for negative B. A solution by numerical methods gives:

(36)
$$B=-1.7145166787397040820$$

It is now possible to evaluate the entropic potential of the N0 levels for the spherical set, which after the calculation of kT from eq. (36) and using the definitions of eq. (31), takes the value:

(37)
$$E_0(T) = kT\left(S_0 + S_{02} + S_{03} + S_{04} + S_{05} + S_{06}\right) = \frac{-\hbar c}{r}\, 0.0072973525199107282$$

The ratio to the most recent experimental value of the alpha constant, 1/137.03599913931, results:

$$1.0000000063622648390^{-1}$$

Thus, a “bubble” of spherical radiation with negative temperature will generate, through the 0-energy levels, an attractive potential in very good agreement with the electrostatic potential[22].

### 3.1 Attraction and repulsion.

So, we showed that the 0-energy level of a *negative* temperature set of spherical radiation corresponds to the electric *attractive* interaction. It could be viewed as "the remains" of the complete set that populated the space between the two charged particles, as consequence of a statistical fluctuation. In the same way, the entropic potential of the 0-energy level of a spherical set of *positive* temperature gives body to a *repulsive* entropic potential. But how to discriminate between the two cases?

22 The here presented calculation, with its 9 digits accuracy, is candidate to be among the most accurate predictions of Physics. In the evaluation of its direct competitor, the (in)famous g-factor calculation by means of QED, it should be considered the large use of ad-hoc terms and freely added renormalization constants. Conversely, here the combination of terms is the only possible for a N=1, S=1/2 particle (See further for a discussion).

Remembering that our sets live into two different sub-fields, consider the following picture.

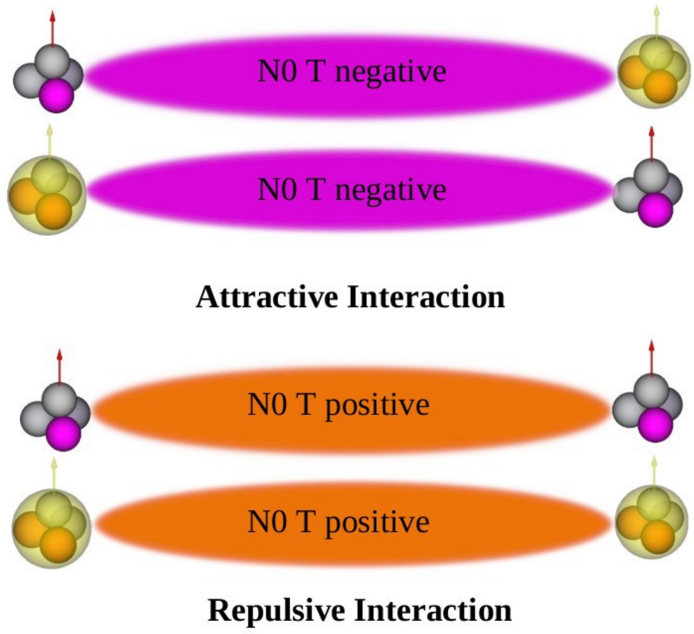



***Figure 5. Attractive and repulsive interaction***

If the two particles show each other opposite temperature sets, there is a net thermodynamic gradient, since any negative temperature is "hotter" than any positive. The N0s between the two particles are thus "heated" with negative temperature and the interaction is attractive. In the other case, when particles show each other the same temperature sets, there is not a definite thermodynamical gradient, neither any difference in entropy for the N0s between the two possibilities. So, which temperature takes the N0 between the two particles, positive or negative? What differentiate the two possibilities is the fraction of boson involved in the fluctuation that populates the spherical set between the particles, which thereafter transmits its temperature to the N0s. For "building up" a negative temperature spherical set, are necessary $N_{SM}(T) \approx 0.78394$ bosons, while for the positive temperature set, $N_{SP}(\overline{T}) \approx 0.000024220$. Thus we can conclude that a fluctuation to a set with positive temperature is about $3.0896*10^5$ more probable with respect a negative one, in absence of a thermodynamical gradient, and this causes the interaction being (mostly) repulsive. But if we exclude any physical effect that could block the fluctuations from the negative T set, then we must conclude that there is also a small attractive component. This implies a slight asymmetry between electric attractive and repulsive interaction, being the repulsive a little weaker.

Although thinking that electric interaction is not symmetric can be a little disturbing, the real issue is if this asymmetry could have been overlooked by experiments. For example, the quantum Hall experiments that allow a 10 digits measurement of the alpha constant are based on the Hall tension, which in turn is due to the unbalance between negative and positive charges in the Hall conductor. Being originated by an attractive interaction, this tension measure the "pure" side of the electric interaction, without the contribution that leads to the asymmetry.

This contribution is present instead in the repulsive interaction, and is equivalent to postulate a weak attractive force acting between the all half-spin particles, even the neutral ones[23].

### 3.2 Particles' annihilation.

Finally, this scheme explains why particles and antiparticles annihilate. When positive and negative temperature sets are brought to contact, a new equilibrium temperature is reached which is not compatible with eq. (35), and the system returns to its initial state of free radiation[24].

---

23 Neutral particles are easily obtained by placing the positive and negative T sets in the same subfield. The only residual interaction is the weakly attractive term. The order of magnitude seems consistent with the Weak interaction, except that this last is considered to have very short range. This assumption, however, could either be wrong, or there could be a mechanism that block negative T fluctuations over a long range in absence of a temperature gradient. In either of the two cases, we would have reached an *electroweak unification* in a quite elegant and natural way.

24 This would imply that the photon generated after an annihilation is a N=2 packet of our boson radiation. Possibly, photon radiation occurs in a subset of our 4-folded field, but this hypothesis needs further deepening.

## 4. The statistical origin of the Spin.

What has been shown until now is that the population shift defined by eq. (35) leads to a very accurate prediction of the alpha constant. However, no reason has been indicated according which the boson should undergo exactly this population shift, between millions of possible combinations. What we are going to show is that this combination is the only compatible with the Spin value and with the Spin algebra.

In the modern Physics, the spin is assumed to have essentially an algebraic origin, perfectly described by the Pauli matrices, which have been later incorporated into Dirac equation to create a relativistic description of half-spin particles. Although this scheme has surely a solid justification, it must be stressed out that to *invoke an algebraic structure to solve a physical problem* is not a flawless process. Once that the spin is declared to exist as algebraic incarnation of some symmetry group, the Physics, intended as cognitive survey, has declared *game over*, in the sense that there is no hope to explain the phenomena in other and maybe better way. Moreover, the value of the gyromagnetic ratio of the electron, very near to 2, is a *clear indication that the spin and magnetic moment are both due to the rotation of a charged, massive object* and not to an algebraic structure, which is likely to be a *consequence* of the value of the spin, and not the *cause* of it. Finally, the description by mean of the Pauli Matrices or by the Dirac equation is elegant but incomplete, since cannot justify the small discrepancy of the gyromagnetic ration from 2, and to justify it, it is necessary to make use of the cumbersome machinery of the QED with its questionable renormalization procedures. It is possible to solve all these problem at once by examining the properties of what we called the Spin-Charge Tetrahedron, and by making use of the properties of a statistical set and of two basilar assumptions.

## 4.1 Spin generation mechanism.

The more relevant assumption that we need to calculate the Spin is about the origin of the mass. As for the calculation of alpha, where we identified the entropic potential of the 0-energy levels as responsible of the electric interaction, in the same way we assume that the metric sum of the entropic potentials is responsible of the mass. The sum has to be taken over the two subfield, and the first subfield is supposed to have a metric factor -1. Unlike the ones involved in the electric interaction, these entropic potentials are in the Gran Canonical form, thus including the contribution of the chemical potential -μβN=-CN, but this term takes a different sign for positive or negative temperature sets: for the negative temperature the sign is inverted[25]:

(38) $$E_{SM}=kT\left(\sum_x \ln(1+|Nx|)+C\,Nx\right)=-3.563959314691978987\frac{\hbar c}{r}$$

Where the sum spans over the various levels x=11, 112, 113....116. As for the populations, each spherical term of the entropic potential is accompanied by its 0-levels terms:

(39) $$E_{SM\,0}=\left(\left(\ln(1+N\,0/3)+C\,N\,0/3\right)+\left(\ln(1+N\,02/3)+C\,N\,02/3\right)+\ldots\right)kT$$

The second assumption is about the mechanism that generates the Spin, which we call *dislocation*. This is nothing other that a basic property of every statistical set, that is, to populate a nearby set with identical energy and geometry. If we look at the Spin-Charge Tetrahedron, we can see that there are four different spheres where the negative temperature set (the purple ball) could "live" without altering his statistical properties. In this situation, the boson's fraction that populates the set is pushed to occupy all the possible configurations, "jumping" from one sphere to the other. If the jumps occur in sequence, the effect is equivalent to a

25 The reason for this sign-change is not clear, but it is possibly linked to the relation between entropy and temperature: unlike ordinary matter, negative temperature's system are know to attain a minimum in the entropy as stationary state. If this has to holds also when adding particles, with a negative C it requires a sign-change in the definition of Entropy.

rotating mass, and thus it generates an angular momentum, as shown in Figure 6.

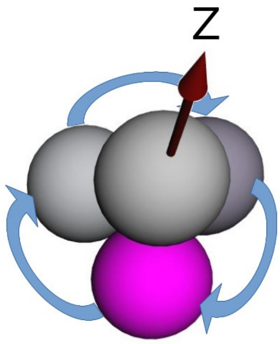



***Figure 6. Sequential dislocation and Spin in the Spin-Charge Tetrahedron***

Also the two -N0 levels (the gray balls) and their N02,N03,.. children are supposed to participate the dislocation. These sets, like any other, have a definite temperature and entropic potential. To calculate them, the procedure is the same of the sets in absence of a temperature gradient, as seen for the repulsive interaction. The temperature is the positive $\bar{\bar{T}}$, with a small 3.089*10 $^{-5}$ negative part. Taking as usual into account contact terms, their contribution to the mass is:

(40)
$$E_{20}(T)=\left|\begin{matrix}2(\ln(1+N0)-CN0)\\+3(\ln(1+N02)-CN02)\\+4(\ln(1+N03)-CN03)\\+5(\ln(1+N04)-CN04)\\+6(\ln(1+N05)-CN05)\\+7(\ln(1+N06)-CN06)\end{matrix}\right|(1-3.089\,10^{-5})(-kT)$$

The total mass involved in the dislocation is thus:

(41)
$$m_D=|E_{SM}+E_{SM0}+E_{20}|$$

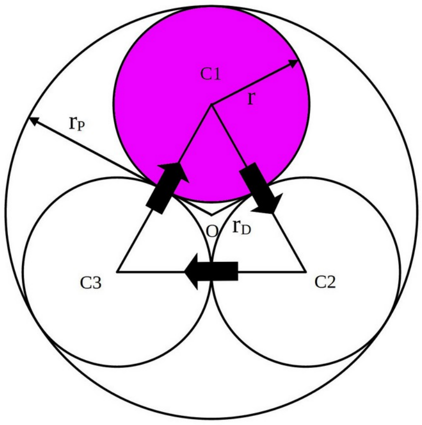



***Figure 7. Dislocation scheme.***

By looking at the geometrical construction of Figure 7, is easy to see that the effective radius of the circular motion with respect to the origin is:

$$r_D = r\frac{\sqrt{3}}{3} \qquad (42)$$

Having mass and radius, only the velocity lacks to calculate the angular momentum. In this case, it is given by the distance covered by the dislocation, which is 2r, divided by the twice time necessary to complete an oscillation inside a sphere of radius r[26], which is 8r/c. The result is c/4.

All quantities in $m_D$ can be easily evaluated numerically in the form constant · $\frac{\hbar c}{r}$ , putting them together brings:

$$m_D = 3.4641018370426930741\frac{\hbar c}{r} \qquad (43)$$

and for the angular momentum:

$$L = r\frac{\sqrt{3}}{3}\frac{c}{4}\frac{m_D}{c^2} = 0.50000003202921899248\hbar \qquad (44)$$

The ratio to the expected value for a fermion is: 1.0000000653617349812. Although a little lower that the accuracy of the calculation of alpha,  this value is sharp enough to draw some conclusions, remembering that no ad hoc term has been added to obtain it, and the terms and the geometry of the Spin-Charge tetrahedron, are

26 Before to dislocate to a nearby sphere, the radiation must complete at least one oscillation.

exactly the same that lead to the calculation of alpha:

1) Spin and Charge are two deeply linked features of the same statistical object, made of "radiation bubbles" for a total population of 1 boson.

2) If we assume N=1 and the Spin possessing an integer or half-integer value[27], the only possible combination of sets and geometry fixes the charge to its value given by alpha *and* the spin to 1/2.

3) The spin is originated by masses dislocating at subatomic scale, but the statistical nature of this mechanism differentiates the spin from a classical angular momentum. Once fixed the Z axis, only two dislocation sequences are possible for the conservation of angular momentum: clockwise and counter-clockwise. The boson population, however, can statistically realize both cases at the same time, with different probability. If we call these two states |+> and |-> the general state will be: *a* |+> + *b* |->, where the statistical weights *a,b* are complex number to take into account the relative phase of the dislocation which is happening in the two states and $|a|^2+|b|^2=1$ . From these statements and from the fact that +> and |-> must be autostates of the $S_Z$ and $S^2$ operators, follow the Pauli matrices and the Spin algebra SU(2), which *in turn* requires the Spin to be 1/2, consistently with the construction of the Spin-Charge Tetrahedron and with the fact that all leptons possess same charge and spin. From this last fact we can deduce that all leptons (but also all fermions) contains the Spin-Charge Tetrahedron.

To resume what we have described until now, starting with a radiation set of 1 Boson, the population shift is a stochastic process, and can thus give any kind of combination in term of sets and temperatures, but only one is stable. Once that the Spin started his dance, the conservation of angular momentum blocks a part of the N=1 boson population in the Spin-Charge tetrahedron configuration and the other in the Static Tetrahedron, with

27 With this requirements we are clearly already quantum-mechanical, this is however not an axiom arbitrary set, but it is necessary for the statistical nature of the Spin, as described in short.

the associated T and $\overline{T}$ temperatures. These temperatures, transferred by statistical fluctuations to an ubiquitous N0 level, give the electric and possibly the weak interactions, while the sequential dislocation of the negative T sets creates the Spin. This process occurs every time that an electron is created and every instant of its existence, and could be seen as an *eternal golden tray*[28].

## 4.2 Calculation of the Magnetic Moment.

To put the model to a final test, we are going to calculate the magnetic moment associated with this configuration. It's evident from what shown until now that the spherical set $N_{SM}$ of the Spin-Charge group is the source of the electric interaction, and it is put in rotational motion by the dislocation mechanism. For a charged mass $m_D$ in rotation, the ratio of the angular momentum to the magnetic moment is given by the well known gyromagnetic ratio of classical mechanics: $\mu_e = \frac{e}{m_D} l$ . But $m_D$ is not the total mass of the electron, since by hypothesis there is the mass of the Static Tetrahedron to take into account, and also one -N0 set ot the Spin-Charge Tetrahedron does not rotate. To summarize the static sets of the model, refer to Figure 8.

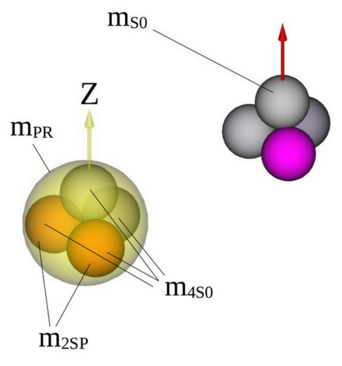



***Figure 8. The static sets.***

All the terms have been already defined within the population shift, all

28 With all the due respect for Kurt Goedel, Maurits Cornelis Esher and Johann Sebastian Bach.

that remains to do is to calculate their masses. The most important of these static terms is the mass of the 1/4 of boson that remains in the original primal radiation state, indicated as $m_{PR}$. As assumed in the definition of static tetrahedron, this radiation is confined into the sphere enclosing the static tetrahedron. In this geometry, the radius of the such a sphere is given by:

(45) $$r_P=\frac{r}{\sqrt{6}-2}$$

For calculating the temperature of the radiation of this set, named $T_{PR}$, it's sufficient to assume that the volume V that appears in (19) is of spherical form, to get:

(46) $$\frac{4\pi r^3}{3}=\frac{\beta^3 h^3 c^3}{16\pi}\frac{\left(\frac{1}{4}-\frac{2}{e^{-C}-1}\right)}{Polylog(3,e^C)}$$

Solving with respect to β we get:

(47) $$kT_{PR}=3.5640417679609246520\frac{hc}{r}$$

This is value of the temperature for the a set of primal radiation of radius r. To calculate the entropic potential, and thus the mass, the temperature must be multiplied for the value of the entropy (with -μN) of the primal radiation $S_{PR}$, which is constant, and for the geometrical factor $\sqrt{6}-2$ for the sphere enclosing the tetrahedron. The $S_{PR}$ is evaluated easily from eq. (21) as $S_{PR}$ =E*4/3/kT=.94990612804757057104. The $N_{PR}$ is by hypothesis (see eq. (18) ) equal to 1/4-N0. The result for the mass of the primal set is:

(48) $$m_{PR}=(S_{PR}-N_{PR}C)kT_{PR}=3.4577298523699493656\frac{\hbar c}{r}$$

The other non-rotating masses are:

-the mass of the static single N0 element[29] of the Spin-Charge

29 This term contains only the repulsive term (positive T), as if the negative T set could not project itself onto this

Tetrahedron, with its contact terms, changed of sign from the metric factor -1:

(49)
$$m_{S0}=\begin{pmatrix}(\ln(1+N0)-CN0)+3(\ln(1+N02)-CN02)\\+5(\ln(1+N03)-CN03)+7(\ln(1+N04)-CN04)\\+9(\ln(1+N05)-CN05)+11(\ln(1+N06)-CN06)\end{pmatrix}(kT)\frac{\hbar c}{r}$$

-the two positive T sets of the Static Tetrahedron with their contact terms:

(50)
$$m_{2SP}=\begin{pmatrix}2[\ln(1+N11)-CN11]\\+3[\ln(1+N112)-CN112]\\+4[\ln(1+N113)-CN113]\\+\dots\end{pmatrix}(-kT)$$

-and the four 1/3 N0 levels which occupy the four spheres of the static tetrahedron and their contact terms. Two of these are obtained by summing the -2/3 N0 population to the background N0 belonging to the primal set.

(51)
$$m_{4S0}=\begin{pmatrix}4[\ln(1+N0/3)-CN0/3]\\+10[\ln(1+N02/3)-CN02/3]\\+16[\ln(1+N03/3)-CN03/3]\\+\dots\end{pmatrix}(-kT)$$

These terms are the static part of the mass:

(52)
$$m_{STATIC}=m_{PR}+m_{S0}+m_{2SP}+m_{4S0}$$

To calculate the gyromagnetic ratio, consider that since $m_D$ is the rotating mass, holds;

(53)
$$\mu_e=\frac{e}{2m_D}S$$

since it also holds by definition of gyromagnetic factor $g_e$:

(54)
$$\mu_e=g_e\frac{e}{2m_e}\frac{\hbar}{2}$$

It follows:

---

domain. The reasons can be understood if one think carefully to the nature of the Spin.

(55) $$g_e = \frac{m_e}{m_D} 2 \frac{S}{\hbar} = \frac{m_D + m_{STATIC}}{m_D} \frac{2S}{\hbar}$$

Being the electron mass $m_e$ the sum of the static and dislocating mass. Using the values of masses already calculated in eq. (38), (42) and (53), and the value of the Spin calculated in (44)[30], the numerical result is:

(56) $$g_e = 2.0023192022269826770$$

the ratio to the most recent experimental value for $g_e$ which is 2.0023193043614656 is:

(57) $$\frac{g_e}{g_{\exp}} = 1.0000000477251626090^{-1}$$

Which shows that once again the model's predictions accuracy is of of 8 digits.

## 5. Conclusions and Perspectives.

The capacity of delivering two $10^{-9}$ and one $10^{-10}$ accurate predictions from the same object should hopefully smear out the widespread belief that the QFT, a method that the great Richard Feynman himself thought worth of 10 years lifespan, is the "cutting edge" method for understanding particles' physics.

The 9-digits calculation of the alpha constant solves a very old problem, defined by the same Feynman as "the biggest mystery of Physics" and open a perspective for a better comprehension of elementary particles and their interactions.

The 8-digits prediction of the electron magnetic moment shows that its origin lays in the structure of the electron, and not in the "vacuum polarization" by mean of QED[31].

The natural asymmetry of the electric interaction could offer a

30 Obviously the Spin is 1/2 with no decimals, but using the value previously calculated tests better the consistency of the model .

31 Although is possible that Julian Schwinger & Co. accidentally caught an approximation of the method described in this paper.

straightforward explanation for the weak interaction, more physically senseful than postulating ad-hoc particles like the vector bosons $W^{\pm}$ and $Z^0$.

Finally, the calculations of the electron's Spin and of the magnetic moment indicate that the origin of mass lays in the entropic potential of a statistical set, and not in the Higg's mechanism[32].

## 5.1 Model completeness.

The model is not complete, since it lacks an equation to define a statistical distribution over the the radius r, on which all statistical set are build. At present state and on the numerical evidence of the calculations here shown, we can just affirm that *the electron is a set ( with a continuous index r) of statistical sets (the Spin-Charge and Static tetrahedrons) in a four-folded field populated with boson radiation.* The identification of the equation that fixes the distribution over r, the mean value of r, and thus the mass of the electron, should also include the Schroedinger's equation, of which the origin has never been clarified yet, as residual equation for the energy of the particle[33].

## 5.2 Expansion of the model.

Another direction of survey is the modeling, by mean of the same sets which constitute the electron, of heavier particles like Leptons, or Fermions, to explicitly calculate all their properties, as it happens in Chemistry with the Periodic Table of Elements. By using a linearity argument and assuming known the electron mass, this should be possible also without knowing the equation that lead to the calculation of a mean r.

## 5.3 Refinement of the model.

32 Only a quite dumb physicist could think that the mass derives from different mechanisms for different particles. The explicit calculation of the mass, however, requires a further leap of intuition, as discussed hereafter.

33 Of course to take such a challenge one must be a Physicist with Attributes. The reader is invited to self-examinate in this sense.

Some aspects of the here presented model need a deeper investigation. A non exhaustive list:

1) the sign-change in the definition of Entropy for negative temperature sets eq. (38).

2) the relation of the boson radiation to the electromagnetic radiation and/or to gravitational radiation[34].

3) the consistency of the approximations used, in particular of the discrete to continuous approximation in the primal set, and the expressions for the PVO (16) and (31). Better approximations could lead to an even better accuracy of the predictions.

## 5.4 Conclusions.

To rewrite from the base in a decent way the Quantum Mechanics is a task at the limit of human mind, probably beyond the possibilities of a single author, and yet it is a necessary step to achieve a deeper comprehension of the Physics, as hopefully we have shown in this paper.

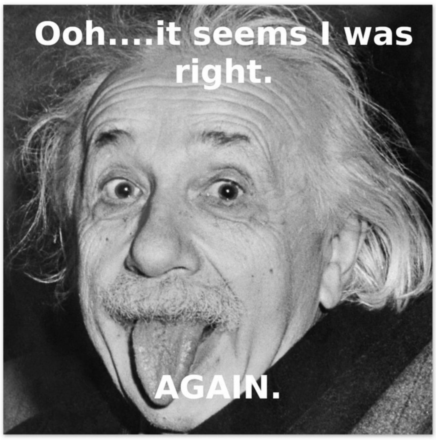
However, we can decide that numerical evidences are nuts and understanding the quantum world is not so important, w.r.t. other considerations regarding e. g. power-games, academic feudalism, and all the crap that affected every human group since the dawn of mankind.

In this way, we would degrade the scientifical community (trough its member who are studying these topics) to something like no-vax and climate-change deniers with a very good algebra knowledge, but the Standard Model would remain there, useless and shining as fool's gold, for many decades.

34 Having removed the necessity of postulating the electric charge, the path to the "electro-gravitational unification", on which Albert Einstein worked without success in his last years, seems a little more feasible.

All calculations reported in this paper are printed in the Appendix as Maple worksheet. The file is available for download at: https://drive.google.com/file/d/15yZRPcoDi8auNaN93E0LtCdJqV7De5M8/view?usp=sharing

For contacts, opinions, suggestions, collaborations: afazzo@outlook.it



# Appendix - Calculations

CALCULATON OF C=beta*mu

Energy of the black-body in the discrete to continuous approx. eq. (4). Vfactt=8PiV/(h*c)^3

```
> Digits:=20;E:=polylog(4,exp(mu/kT))*GAMMA(4)*kT*Vfactt*(kT)^3;
```

$$Digits := 20$$

$$E := 6\ \mathrm{polylog}\left(4, e^{\frac{\mu}{kT}}\right) kT^4\ Vfactt \tag{1}$$

Population of the black-body in the discrete to continuous approx. eq. (3)

```
> N:=polylog(3,exp(mu/kT))*GAMMA(3)*Vfactt*(kT)^3;
```

$$N := 2\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right) Vfactt\ kT^3 \tag{2}$$

Symbolic calculation of the derivatives of E w.r.t. mu and kT, definition of tan_a as the ratio.

```
> dEdmu:=diff(E,mu);dEdkT:=diff(E,kT);tan_a:=simplify(-dEdkT/dEdmu);
```

$$dEdmu := 6\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right) Vfactt\ kT^3$$

$$dEdkT := -6\ \mu\ kT^2\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right) Vfactt + 24\ \mathrm{polylog}\left(4, e^{\frac{\mu}{kT}}\right) kT^3\ Vfactt$$

$$tan\_a := \frac{\mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right) \mu - 4\ \mathrm{polylog}\left(4, e^{\frac{\mu}{kT}}\right) kT}{kT\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right)} \tag{3}$$

Symbolic calculation of the derivatives of N w.r.t. mu and kT.

```
> dNdkT:=diff(N,kT);dNdmu:=diff(N,mu);
```

$$dNdkT := -2\ \mu\ kT\ \mathrm{polylog}\left(2, e^{\frac{\mu}{kT}}\right) Vfactt + 6\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right) Vfactt\ kT^2$$

$$dNdmu := 2\ kT^2\ \mathrm{polylog}\left(2, e^{\frac{\mu}{kT}}\right) Vfactt \tag{4}$$

Symbolic calculation of the total differential of N multiplied by mu.

```
> mudN := mu*simplify(dNdkT+tan_a*dNdmu);
```

$$mudN := \frac{2\ \mu\ Vfactt\ kT^2 \left(3\ \mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right)^2 - 4\ \mathrm{polylog}\left(4, e^{\frac{\mu}{kT}}\right) \mathrm{polylog}\left(2, e^{\frac{\mu}{kT}}\right)\right)}{\mathrm{polylog}\left(3, e^{\frac{\mu}{kT}}\right)} \tag{5}$$

Definition of the 0-energy level N0.

```
> N0:=2/(exp(-mu/kT)-1);
```

$$N0 := \frac{2}{e^{-\frac{\mu}{kT}} - 1} \tag{6}$$

Derivatives of N0 w.r.t. kT and mu.

```
> dN0dkT:=diff(N0,kT);dN0dmu:=diff(N0,mu);
```

$$dN0dkT := -\frac{2\ \mu\ e^{-\frac{\mu}{kT}}}{\left(e^{-\frac{\mu}{kT}} - 1\right)^2 kT^2}$$

(7)

$$dN0dmu := \frac{2\, e^{-\frac{\mu}{kT}}}{\left(e^{-\frac{\mu}{kT}} - 1\right)^2 kT} \quad \textbf{(7)}$$

Total differential of N0, multiplied by mu.

```
> mudN0 := mu*(dN0dkT);
```

$$mudN0 := -\frac{2\,\mu^2\, e^{-\frac{\mu}{kT}}}{\left(e^{-\frac{\mu}{kT}} - 1\right)^2 kT^2} \quad \textbf{(8)}$$

Approximate definition of PV for the 0-energy level.

```
> PV0:=2*kT*ln(1+N0/2);
```

$$PV0 := 2\,kT \ln\left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right) \quad \textbf{(9)}$$

Derivatives of PV0 w.r.t. kT and mu.

```
> dPV0dkT:=diff(PV0,kT);dPV0dmu:=diff(PV0,mu);
```

$$dPV0dkT := 2 \ln\left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right) - \frac{2\,\mu\, e^{-\frac{\mu}{kT}}}{kT\left(e^{-\frac{\mu}{kT}} - 1\right)^2 \left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right)}$$

$$dPV0dmu := \frac{2\, e^{-\frac{\mu}{kT}}}{\left(e^{-\frac{\mu}{kT}} - 1\right)^2 \left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right)} \quad \textbf{(10)}$$

Differential of PV0

```
> dPV0:=(dPV0dkT+tan_alpha*dPV0dmu*0);
```

$$dPV0 := 2 \ln\left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right) - \frac{2\,\mu\, e^{-\frac{\mu}{kT}}}{kT\left(e^{-\frac{\mu}{kT}} - 1\right)^2 \left(1 + \frac{1}{e^{-\frac{\mu}{kT}} - 1}\right)} \quad \textbf{(11)}$$

Definition of C.

```
> mu:=C*kT;
```

$$\mu := C\, kT \quad \textbf{(12)}$$

Solution of N+N0=1/4 eq. (18) w.r.t. Vfactt.

```
> Vfactt:=(1/4-N0)/2/polylog(3, exp(C))/(kT)^3;
```

$$Vfactt := \frac{1}{2}\,\frac{\frac{1}{4} - \frac{2}{e^{-C} - 1}}{\operatorname{polylog}(3, e^{C})\, kT^3} \quad \textbf{(13)}$$

Definition of eq. (22) divided by Vfactt*beta^4, in order to obtain an homogeneous equation in C.

```
> beta:=1/(kT):Ceq:=expand((((4/3*E/Vfactt+PV0/Vfactt-mudN0*kT/Vfactt-mudN*
  kT/Vfactt-dPV0*kT/Vfactt))*beta^4));
```

$$Ceq := 8 \operatorname{polylog}(4, e^{C}) + \frac{4\, C^2 \operatorname{polylog}(3, e^{C})}{\left(\frac{1}{e^{C}} - 1\right)^2 e^{C} \left(\frac{1}{4} - \frac{2}{\frac{1}{e^{C}} - 1}\right)} - 6\, C \operatorname{polylog}(3, e^{C}) \quad \textbf{(14)}$$

$$+\frac{8\,C\,\mathrm{polylog}(4,e^{C})\,\mathrm{polylog}(2,e^{C})}{\mathrm{polylog}(3,e^{C})}+\frac{4\,\mathrm{polylog}(3,e^{C})\,C}{\left(\frac{1}{4}-\frac{2}{\frac{1}{e^{C}}-1}\right)\left(\frac{1}{e^{C}}-1\right)^{2}e^{C}\left(1+\frac{1}{\frac{1}{e^{C}}-1}\right)}$$

Solution of eq. (22) w.r.t. C

```
> Csol:=fsolve(Ceq=0,C=-10..-2);
```

$$Csol := -5.0868580117334065176 \qquad (15)$$

CALCULATION OF B AS SOLUTION OF Ntot=1

Assignment to C of the value obtained from cartesian black body computation (also called primal field).

```
> C:=Csol;
```

$$C := -5.0868580117334065176 \qquad (16)$$

Entropy of the primal field.

```
> Spr:=E*4/3/kT;
```

$$Spr := 0.94990612804757057104 \qquad (17)$$

Definition of the PV for N0.

```
> PV0:=kT*ln(1+N0);
```

$$PV0 := 0.012354954640721038174\,kT \qquad (18)$$

Definition of e11, the energy of the spherical mode with L=1, m=1. Definition of N11, its population and PV11, its entropic potential.
from now on, the populations are written as functions of the pure numbers B=(h*c)/r*beta and C= mu/kT. This because C is assumed constant from precedent calculation and B is the variable to solve for.

```
> mu:=C/beta:e11:=2/3*B*BesselJZeros(1+1/2,1)/beta;N11:=2/(exp(e11*beta-beta*
  mu)-1);PV11:=1/beta*log(1+abs(N11));
```

$$e11 := \frac{2}{3}\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)kT$$

$$N11 := \frac{2}{e^{\frac{2}{3}B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1}$$

$$PV11 := kT\ln\left(1+\frac{2}{\left|e^{\frac{2}{3}B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|}\right) \qquad (19)$$

Definition of the entropy of N11 level.

```
> S11:=(E11+PV11)/(kT)-C*N11;
```

$$S11 := \frac{E11+kT\ln\left(1+\frac{2}{\left|e^{\frac{2}{3}B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|}\right)}{kT}+\frac{10.173716023466813035}{e^{\frac{2}{3}B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1} \qquad (20)$$

Definition of energy, population and entropic potential for the secondary level N112.

```
> e112:=2*2/3*B*BesselJZeros(1+1/2,1)/beta;N112:=(2/(exp(e112*beta-beta*mu)-1))
  ^2;PV112:=1/beta*log(1+abs(N112));
```

$$e112 := \frac{4}{3}\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)kT$$

$$N112 := \frac{4}{\left(e^{\frac{4}{3}B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{2}}$$

(21)

$$PV112 := kT \ln\left(1 + \frac{4}{\left|e^{\frac{4}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^{2}}\right) \quad \textbf{(21)}$$

Definition of energy, population and entropic potential for the secondary level N113 and followers.

```
> e113:=3*2/3*B*BesselJZeros(1+1/2,1)/beta;N113:=(2/(exp(e113*beta-beta*mu)-1))
^3;E113:=e113*N113;PV113:=1/beta*log(1+abs(N113));
```

$$e113 := 2\, B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT$$

$$N113 := \frac{8}{\left(e^{2 B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{3}}$$

$$E113 := \frac{16\, B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT}{\left(e^{2 B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{3}}$$

$$PV113 := kT \ln\left(1 + \frac{8}{\left|e^{2 B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^{3}}\right) \quad \textbf{(22)}$$

```
> e114:=4*2/3*B*BesselJZeros(1+1/2,1)/beta;N114:=(2/(exp(e114*beta-beta*mu)-1))
^4;E114:=e114*N114;PV114:=1/beta*log(1+abs(N114));
```

$$e114 := \frac{8}{3}\, B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT$$

$$N114 := \frac{16}{\left(e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{4}}$$

$$E114 := \frac{128}{3} \frac{B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT}{\left(e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{4}}$$

$$PV114 := kT \ln\left(1 + \frac{16}{\left|e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^{4}}\right) \quad \textbf{(23)}$$

```
> e115:=5*2/3*B*BesselJZeros(1+1/2,1)/beta;N115:=(2/(exp(e114*beta-beta*mu)-1))
^5;E115:=e115*N115;PV115:=1/beta*log(1+abs(N115));
```

$$e115 := \frac{10}{3}\, B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT$$

$$N115 := \frac{32}{\left(e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{5}}$$

$$E115 := \frac{320}{3} \frac{B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT}{\left(e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^{5}}$$

$$PV115 := kT \ln\left(1 + \frac{32}{\left|e^{\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^{5}}\right) \quad \textbf{(24)}$$

```
> e116:=6*2/3*B*BesselJZeros(1+1/2,1)/beta;N116:=(2/(exp(e116*beta-beta*mu)-1))
^6;E116:=e116*N116;PV116:=1/beta*log(1+abs(N116));
```

$$e116 := 4\, B\, \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) kT$$

$$N116 := \frac{64}{\left(e^{4\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^6}$$

$$E116 := \frac{256\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)\,kT}{\left(e^{4\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^6}$$

$$PV116 := kT\ln\left(1+\frac{64}{\left|e^{4\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^6}\right)$$

Most recent alpha experimental value.

```
> alpha2014:=1/137.03599913931;
```

$$\alpha 2014 := 0.0072973525663384685799 \quad \textbf{(25)}$$

Definition of secondary levels for the 0-energy level. These levels and N0 give body to the electric interaction trough the entropic potential.

```
> N02:=(N0)^2;N03:=(N0)^3;N04:=(N0)^4;N05:=(N0)^5;N06:=(N0)^6;N07:=(N0)^7;
  N08:=(N0)^8;
```

$$N02 := 0.00015454448925685975887$$

$$N03 := 0.0000019212340959761996533$$

$$N04 := 2.3883999159663641424\ 10^{-8}$$

$$N05 := 2.9691614210550645820\ 10^{-10}$$

$$N06 := 3.6911404515414851408\ 10^{-12}$$

$$N07 := 4.5886753533812688335\ 10^{-14}$$

$$N08 := 5.7044541585881352972\ 10^{-16} \quad \textbf{(26)}$$

Calculation of the PV of the secondary N0s in terms of the temperature kT.

```
> PV02:=kT*ln(1+N02);PV03:=kT*ln(1+N03);PV04:=kT*ln(1+N04);PV05:=kT*ln(1+
  N05);PV06:=kT*ln(1+N06);PV07:=kT*ln(1+N07);PV08:=kT*ln(1+N08);
```

$$PV02 := 0.00015453254848751752496\ kT$$

$$PV03 := 0.0000019212322504083380741\ kT$$

$$PV04 := 2.3883998874477296611\ 10^{-8}\ kT$$

$$PV05 := 2.9691614205592040229\ 10^{-10}\ kT$$

$$PV06 := 3.6911404999931877409\ 10^{-12}\ kT$$

$$PV07 := 4.5886799999998947201\ 10^{-14}\ kT$$

$$PV08 := 5.7039999999999983732\ 10^{-16}\ kT \quad \textbf{(27)}$$

Calculation of the PV of the negative T levels.

```
> PVsum_m:=PV11+PV112+PV113+PV114+PV115+PV116;
```

$$PVsum\_m := kT\ln\left(1+\frac{2}{\left|e^{\frac{2}{3}\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|}\right)+kT\ln\left(1\right. \quad \textbf{(29)}$$

$$\left.+\frac{4}{\left|e^{\frac{4}{3}\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^2}\right)+kT\ln\left(1\right.$$

$$\left.+\frac{8}{\left|e^{2\,B\,\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^3}\right)+kT\ln\left(1\right.$$

$$+\frac{16}{\left|e^{\frac{8}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^{4}}\Bigg)+kT\ln\Bigg(1$$

$$+\frac{32}{\left|e^{\frac{8}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^{5}}\Bigg)+kT\ln\Bigg(1$$

$$+\frac{64}{\left|e^{4\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right|^{6}}\Bigg)$$

Definition of the total population of all levels in one set with negative T.

```
> Nsm:=(N11+N112+N113+N114+N115+N116);
```

$$Nsm:=\frac{2}{e^{\frac{2}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1}+\frac{4}{\left(e^{\frac{4}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{2}}+\frac{8}{\left(e^{2\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{3}}+\frac{16}{\left(e^{\frac{8}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{4}}+\frac{32}{\left(e^{\frac{8}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{5}}+\frac{64}{\left(e^{4\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{6}} \quad \textbf{(30)}$$

Definition of the populations of the levels with positive temperature. Since positive temperature is assumed to be abs(T), the values of pupulations are computed simply changing sign of T.
Definitions of the total population in1 set and 2 contiguous sets of positive temperature.

```
> N11p:=(2/(exp(-e11*beta-beta*mu)-1));N112p:=(2/(exp(-e112*beta-beta*mu)-1))
  ^2;N113p:=(2/(exp(-e113*beta-beta*mu)-1))^3;N114p:=(2/(exp(-e114*beta-beta*
  mu)-1))^4;N115p:=(2/(exp(-e115*beta-beta*mu)-1))^5;N116p:=(2/(exp(-e116*
  beta-beta*mu)-1))^6;Nsp:=(N11p+N112p+N113p+N114p+N115p+N116p);N2sp:=
  (2*N11p+3*N112p+4*N113p+5*N114p+6*N115p+7*N116p);
```

$$N11p:=\frac{2}{e^{-\frac{2}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1}$$

$$N112p:=\frac{4}{\left(e^{-\frac{4}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{2}}$$

$$N113p:=\frac{8}{\left(e^{-2\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{3}}$$

$$N114p:=\frac{16}{\left(e^{-\frac{8}{3}\,B\mathrm{BesselJZeros}\left(\frac{3}{2},1\right)+5.0868580117334065176}-1\right)^{4}}$$

$$N115p := \frac{32}{\left(e^{-\frac{10}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^5}$$

$$N116p := \frac{64}{\left(e^{-4 B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^6}$$

$$Nsp := \frac{2}{e^{-\frac{2}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1} + \frac{4}{\left(e^{-\frac{4}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^2} + \frac{8}{\left(e^{-2 B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^3} + \frac{16}{\left(e^{-\frac{8}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^4} + \frac{32}{\left(e^{-\frac{10}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^5} + \frac{64}{\left(e^{-4 B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^6}$$

$$N2sp := \frac{4}{e^{-\frac{2}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1} + \frac{12}{\left(e^{-\frac{4}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^2} + \frac{32}{\left(e^{-2 B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^3} + \frac{80}{\left(e^{-\frac{8}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^4} + \frac{192}{\left(e^{-\frac{10}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^5} + \frac{448}{\left(e^{-4 B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right)^6} \tag{31}$$

Definition of total entropic potential of one set with positive temperature, for later use.

```
> PV11p:=kT*log(1+abs(N11p));PV112p:=kT*log(1+abs(N112p));PV113p:=kT*log(1+
  abs(N113p));PV114p:=kT*log(1+abs(N114p));PV115p:=kT*log(1+abs(N115p));
  PV116p:=kT*log(1+abs(N116p));
```

$$PV11p := kT \ln\left(1 + \frac{2}{\left|e^{-\frac{2}{3} B\,\mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|}\right)$$

$$PV112p := kT \ln\left(1 + \frac{4}{\left|e^{-\frac{4}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^2}\right)$$

$$PV113p := kT \ln\left(1 + \frac{8}{\left|e^{-2 B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^3}\right)$$

$$PV114p := kT \ln\left(1 + \frac{16}{\left|e^{-\frac{8}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^4}\right)$$

$$PV115p := kT \ln\left(1 + \frac{32}{\left|e^{-\frac{10}{3} B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^5}\right)$$

$$PV116p := kT \ln\left(1 + \frac{64}{\left|e^{-4 B \mathrm{BesselJZeros}\left(\frac{3}{2}, 1\right) + 5.0868580117334065176} - 1\right|^6}\right) \quad \textbf{(32)}$$

$$Csol := -5.0868580117334065176$$

$$C := -5.0868580117334065176 \quad \textbf{(33)}$$

Definition of the N0 levels of a spherical set of negative T.

```
> Nsm0:=(N0+N02+N03+N04+N05+N06)/3;
```

$$Nsm0 := 0.0041960274313895625434 \quad \textbf{(34)}$$

Definition of the N0 levels of two contiguous spherical sets of positive T.

```
> N2sp0:=(2*N0+3*N02+4*N03+5*N04+6*N05+7*N06)/3;
```

$$N2sp0 := 0.0084448748013013123631 \quad \textbf{(35)}$$

Definition of the N0 levels of a domain populated by -2/3N0.

```
> N02_3:=(-2/3*(N0+N02+N03+N04+N05));
```

$$N02\_3 := -0.0083920548603183647858 \quad \textbf{(36)}$$

Definition and solution of the equation (35) Ntot=1 in terms of B. All terms are described in the paper.

```
> Bsol:=fsolve(Nsm/3+N2sp/3-3*N0-6*N02-9*N03-12*N04-15*N05+N2sp0+Nsm0+
  N02_3+1/4=1,B=-2..-1.65);
```

$$Bsol := -1.7145166787444841129 \quad \textbf{(37)}$$

Definition of the total entropic potential of the N0 levels multiplied by r/(h/2/Pi*c). This number can be confronted with alpha.

```
> PV0sum_number:=(PV0+PV02+(PV03)+(PV04)+PV05+PV06)*beta/Bsol;
```

$$PV0sum\_number := -0.0072973525199107792247 \quad \textbf{(38)}$$

Calculation of the ratio to the alpha value.

```
> PV0sum_ratio:=evalf((PV0sum_number)/alpha2014);1/%;
```

$$PV0sum\_ratio := -0.99999999363773520148$$

$$-1.0000000063622648390 \quad \textbf{(39)}$$

CALCULATION OF THE SPIN

From now on, all calculations are on the B solution of eq (35).

```
> B:=Bsol;
```

$$B := -1.7145166787444841129 \quad \textbf{(40)}$$

Calculation of total population of one positive temperature set and of one negative temperature set. Calculation of the ratio.

```
> None_Tplus:=evalf(subs(B=Bsol,Nsp));None_Tminus:=evalf(subs(B=Bsol,Nsm));
  weak_ratio:=None_Tplus/None_Tminus;
```

$$None\_Tplus := 0.0000726620388339016827970$$

$$None\_Tminus := 2.351827012593327696$$

$$weak\_ratio := 0.0000308959963657268481350 \quad (41)$$

Calculation of the entropic potential of a negative T set, including N*mu terms. All entropic potentials are evaluated in units h*c/r.

```
> Esm:=evalf(subs(kT=1/Bsol,(PVsum_m+Nsm*C/Bsol)));
```

$$Esm := -3.563959319206766010 \quad (42)$$

```
> E20:=-1/Bsol*(1-weak_ratio)*(2*(ln(1+N0)-C*N0)+3*(ln(1+N02)-C*N02)+4*(ln(1+
  N03)-C*N03)+5*(ln(1+N04)-C*N04));
```

$$E20 := 0.08985049923076121946500 \quad (43)$$

Calculation of the total dislocating mass

```
> dislocating_mass:=(Esm-1/Bsol*(1-weak_ratio)*(2*(ln(1+N0)-C*N0)+3*(ln(1+N02)-
  C*N02)+4*(ln(1+N03)-C*N03)+5*(ln(1+N04)-C*N04))+1/Bsol*(ln(1+N0/3)+C*
  N0/3+1*(ln(1+N02/3)+C*N02/3)+1*(ln(1+N03/3)+C*N03/3)+(ln(1+N04/3)+C*
  N04/3)));
```

$$dislocating\_mass := -3.464101841557446304 \quad (44)$$

Calculation of the angular momentum created by the disclocation, and its ratio to 0.5.

```
> SPIN:=evalf(dislocating_mass*tan(Pi/6))/4;SPIN/0.5;
```

$$SPIN := -0.5000000326808674906$$

$$-1.000000065361734981 \quad (45)$$

Gyromagnetic factor of the electron divided by 2.

```
> g[elett]:=2.0023193043625635;
```

$$g_{elett} := 2.0023193043625635 \quad (46)$$

Calculation of the temperature of a primal set of radius r.

```
> kTprimal:=evalf(solve(4/3*Pi*(r)^3=19.213974895979572831/(K^3*T^3)/(8*Pi)*
  c^3*h^3,T)[1]*K/h/c*r*2*Pi);
```

$$kTprimal := 3.564041767960924652 \quad (47)$$

Calculation of the entropic potential of a primal set of radius r as E+PV-mu*N=4/3*E-C*N*kTp.

```
>  entropic_pot_primal:=(Spr-(1/4-N0)*C)*kTprimal;
```

$$entropic\_pot\_primal := 7.692566755717641190 \quad (48)$$

Calculation of the entropic potential of the primal set encircling the Static Thetrahedon ( a sphere of radius r/(sqrt(6)-2)).

```
> mpr:=(entropic_pot_primal)*evalf(sqrt(6)-2);
```

$$mpr := 3.457729852369949365 \quad (49)$$

Entropic potential of 2 positive T spheres with contact terms. Member

```
> m2sp:=evalf(subs(kT=1/Bsol,(2*PV11p+3*PV112p+4*PV113p+5*PV114p+6*
  PV115p+7*PV116p)-(2*N11p+3*N112p+4*N113p+5*N114p+6*N115p+7*N116p)*
  C*kT));
```

$$m2sp := -0.0005159248428502434669 \quad (50)$$

Entropic potential of 4  positive T spheres populated by N0/3 with contact terms

```
> m4s0:=subs(kT=1/Bsol,-kT*(4*(ln(1+N0/3)-C*N0/3)+10*(ln(1+N02/3)-C*N02/3)
  +16*(ln(1+N03/3)-C*N03/3)+22*(ln(1+N04/3)-C*N04/3)+28*(ln(1+N05/3)-C*
  N05/3)+4*(ln(1+N06/3)-C*N06/3)));
```

$$m4s0 := 0.06069190034972929245 \quad (51)$$

Entropic potential of the single N0 sphere of the Spin-Charge thetrahedon not taking part to dislocation, with contact terms to the others two N0 spheres.

```
> ms0:=-((ln(1+N0)-C*N0)+3*(ln(1+N02)-C*N02)+5*(ln(1+N03)-C*N03)+7*(ln(1+
  N04)-C*N04))*1/Bsol*(1-0*weak_ratio);
```

$$ms0 := 0.04577046420346179770 \quad (53)$$

Total mass of the electron as metric sum of all the entropic potentials. The potentials from the first subfield are changed in sign.

```
> effective_total_mass:=m2sp+m4s0-(dislocating_mass)+mpr-(ms0);
```

$$effective\_total\_mass := 6.9362372052308129209 \quad (54)$$

Gyromagnetic factor of the electron and its ratio to experimental value.

```
> MU_ratio_electron:=(effective_total_mass)/(abs(dislocating_mass))*(2*SPIN);
```

$$MU\_ratio\_electron := -2.0023192088015536648 \quad (55)$$

```
> MU_ratio_electron/g[elett];1/%;
```

$$-0.99999995227483966868$$

$$-1.0000000477251626090 \quad (56)$$