

EPS Roots & Future

ANTONINO ZICHICHI⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾⁽⁵⁾⁽⁶⁾

⁽¹⁾ *University of Bologna and INFN - Bologna Italy*

⁽²⁾ *CERN - Geneva, Switzerland*

⁽³⁾ *Enrico Fermi Centre - Rome, Italy*

⁽⁴⁾ *Pontifical Academy of Sciences - Vatican City*

⁽⁵⁾ *World Federation of Scientists - Beijing, Geneva, Moscow, New York*

⁽⁶⁾ *Ettore Majorana Foundation and Centre for Scientific Culture - Erice, Italy*

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Among the founders of EPS I was the youngest fellow. During many years before 1968 I was active in trying to get the support of physicists for the creation of the first Institution where physicists from all Europe (East-West-North-South) wanted to be altogether.

During the first EPS meeting (at the University of Geneva) it was given to me the task of explaining why the frontiers of Physics had to be the roots for the future of EPS. Today this has not to be forgotten. Without memory there is neither Civilization nor Science; and since Physics is the queen of all Sciences (Enrico Fermi *dixit*) we should not forget our roots and the new horizons of EPS: i.e. The new Frontiers of Physics.

These frontiers were with Lord Patrick Blackett, who was the leader of the most famous group of physics in the world and the winner of the Mediterranean Battle in the Second World War. It is because of him that I had the privilege of spending an evening with **Bertrand Russell** (a friend of Blackett) and getting to know his views on us physicists who were and are engaged at the frontiers of human knowledge in order to understand the Logic of Nature. Professor Blackett and his friend Bertrand Russell were interested in identifying the real motor for progress in technological inventions. It is this motor that has allowed the quality of life to be at the level it is today.

It is the cultural responsibility of us, the physicist, to recall to the great public that this motor is the scientific discovery at the **1st level of Galilean Science** [1].

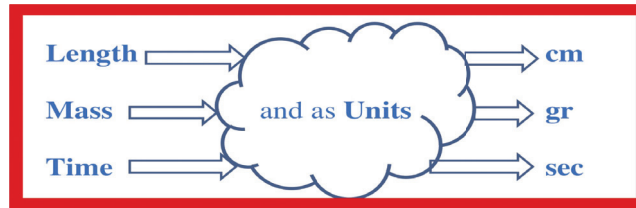
Today, the centre of everyone's attention are the problems concerning the **role of Science** as the source of high quality life instead of being (as it was in the middle of last Century) just the source of high precision and high power weapons.

In the years immediately after the Second World War, the problems on the **role of Science** were far from being of interest to the public. When I had the privilege of being in Professor Blackett's Physics group I learned a lot about these problems, essentially as Professor Blackett was engaged not only in the frontiers of Physics but also with problems concerning the **role of Science** in the Culture of our time.

The role of Science in the Culture of our Time called Modern is 1% Modern and 99% Pre-Aristotelian.

For the Culture of our Time called Modern (*1% Modern and 99% Pre-Aristotelian*) it is as if neither **Rigorous Theoretical Logic** (Mathematics) nor **Rigorous Experimental Logic** (Science) had been discovered. The proof follows.

In everyday's life we use as **Basic Quantities**



In his universal outlook of the world – independent of our restricted environment – Planck in 1899 wanted that the fundamental units of **mass**, **length** and **time** to depend only on the values of the Fundamental Constants of Nature:

- c (the speed of light),
- h (the Planck constant) and
- G (the Newton gravitational coupling).

Planck included the Boltzmann constant K which converts the units of energy into units of temperature. This allowed Planck to have a fundamental value also for the temperature: 3.5×10^{32} kelvins (K).

These quantities had a special meaning for Planck [2]: “*These quantities retain their natural significance as long as the Law of Gravitation and that of the propagation of light in a vacuum and the two principles of thermodynamics remain valid; they therefore must be found always to be the same, when measured by the most widely differing intelligence according to the most widely differing methods*”.

The way Planck considered these quantities is remarkable: “*In the new system of measurement each of the four preceding Constants of Nature (G , h , c , K) has the value one*”.

This is the meaning of measuring lengths, times, masses and temperatures in Planck's units. Our world is coming from the Planck Universe where the units of the **Basic Quantities** are not cm, gr, sec but the fundamental Constants of Nature: c , h , G_N , K . Taking these units, the following values come out:

Length	$= (G \cdot h/c^3)^{1/2}$	$\simeq 10^{-33}$ cm
Time	$= (G \cdot h/c^5)^{1/2}$	$\simeq 10^{-44}$ s
Mass	$= (h \cdot c/G)^{1/2}$	$\simeq 10^{-5}$ g
Temperature	$= (k^{-1} \cdot (hc^5/G)^{1/2})$	$\simeq 10^{32}$ K.

When Planck discovered these **units** no one knew what these quantities have to do with our Universe. This is the reason why Planck's discovery was forgotten during the

XX Century. But now these quantities are those where our life comes from: the **1st Big Bang** [3].

This means that our Universe has its quantitative basis in the intellectual venture whose author is Max Planck [2].

When Planck was expressing his ideas on the meaning of his fundamental natural units there was neither the Big Bang nor the Einstein equation [4]. And no one knew that the Einstein equation had a solution, discovered by Karl Schwarzschild [5], which describes the gravitational field of a massive point-like particle.

The evolution of the Universe seems to follow the conditions illustrated in Figures 1 and 2 whose origin is the Schwarzschild equation and the Fundamental Constants of Nature [6].

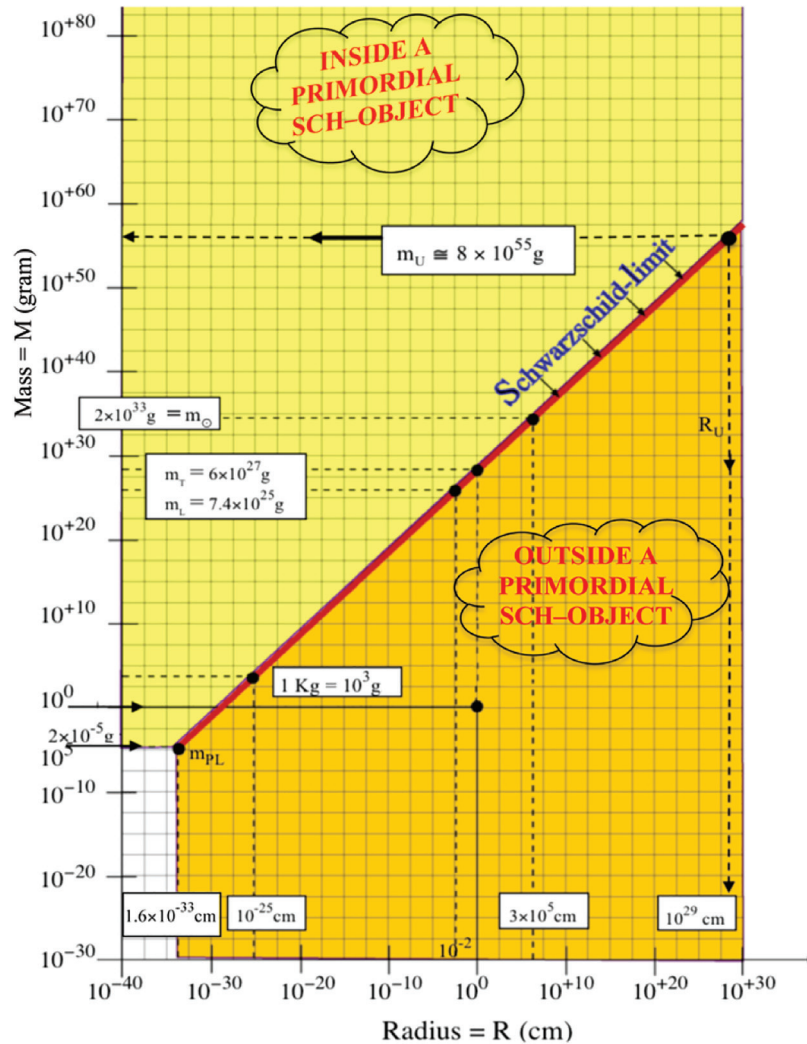


Fig. 1. – The Schwarzschild law between the radius of the gravitational horizon and the mass, from the smallest to the largest Schwarzschild object SCH-object.

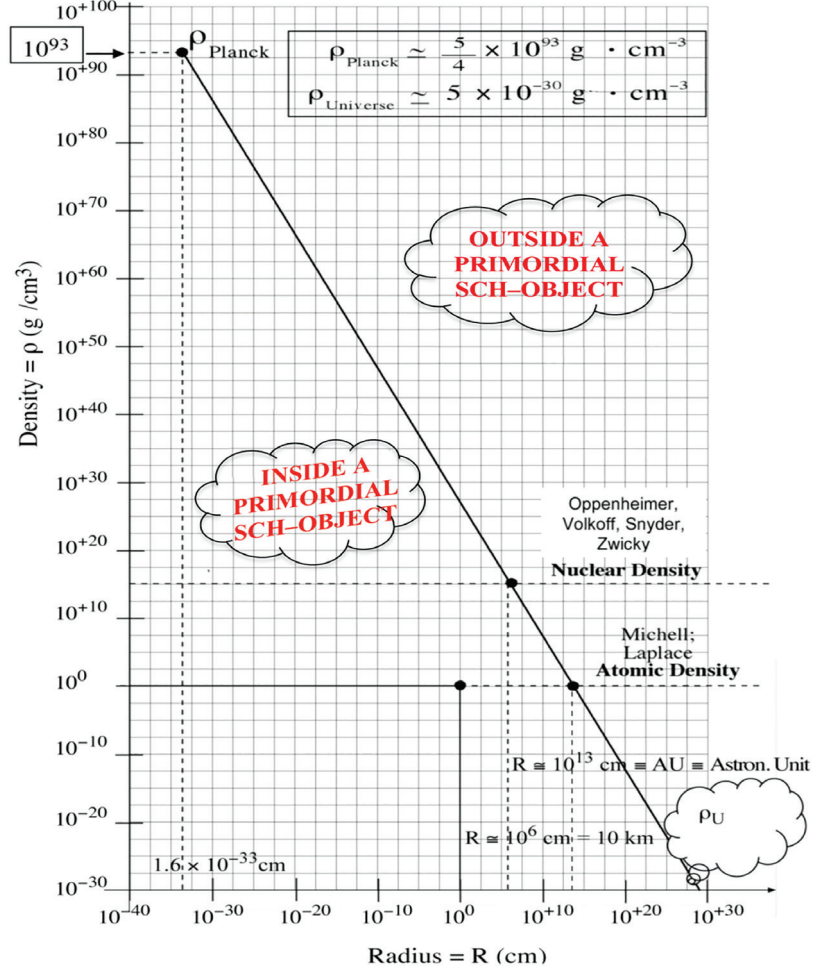


Fig. 2. – The relation which exists between the value of the SCH radius (R_{SCH}) and the corresponding density (ρ_{SCH}), from the smallest (the Planck Universe) to the largest SCH-object (the Universe now).

Now the rigorous description of $\alpha_1 \alpha_2 \alpha_3$. This rigorous description is of high relevance in our time when the mathematics needed to describe the climate has the same structure: i.e. a system of at least three non-linear differential equations coupled. This system has no analytic solution.

No-one will ever be able to derive an equation as simple as the Newton equation. Only mathematical models can be constructed, hoping that they could be very near to the (non existing) simple equation. But mathematical models need to be experimentally checked if they correspond to the real world. This is what we do with the three Fundamental Forces (QED, QFD, QCD), while the fellows working with climatology give as granted the results of their mathematical models.

It should be pointed out that the mathematical models needed to describe the climate have a very large number of “free parameters”. The father of this mathematics, John von Neumann, was quoted by Enrico Fermi when, in the middle of last Century, a theoretical

physicist was claiming of having built a mathematical model able to describe all known experimental results of Nuclear Physics. Fermi asked him how many free parameters he had in his model. The answer was: many.

Fermi recalled him the von Neumann statement: “If you allow me to have three free parameters I can build a model which describes an elephant. If you allow me a fourth free parameter my model will predict that the elephant will fly”.

This was the end of the most exact mathematical model able to describe all known experimental features of the Nuclear Forces.

Nobody could imagine that the Nuclear Forces are secondary effects produced by the “Gauge Force” (Quantum Chromo Dynamics, QCD) which acts between quarks and gluons. If we switch off QCD, the Nuclear Forces disappear. The mathematical rigor and the needed experimental checks are the basis of all activities which can be called scientific.

This is the reason why the rigorous description of $\alpha_1 \alpha_2 \alpha_3$ produces a number of experimental checks, and this is the lesson we give to those engaged in climatology, where analogous checks are not considered. We will see in Figure 3 that nobody predicted the EGM effect and nobody could have predicted the GAP.

THE UNIFICATION OF ALL FUNDAMENTAL FORCES AND THE EGM EFFECT

The three lines ($\alpha_1^{-1}, \alpha_2^{-1}, \alpha_3^{-1}$) in **Figure 4** result from calculations executed with a supercomputer using the following system of equations:

$$\mu \frac{d\alpha_i}{d\mu} = \frac{b_i}{2\pi} \alpha_i^2 + \sum_j \frac{b_{ij}}{8\pi^2} \alpha_i \alpha_j$$

α_i, α_j (with $i = 1, 2, 3$; and $j = 1, 2, 3$ but $i \neq j$).

This is a system of coupled non-linear differential equations which is valid to mathematically describe an experiment where three quantities play a fundamental role. In our case the three fundamental quantities are the gauge couplings ($\alpha_1, \alpha_2, \alpha_3$) which vary with “ μ ”, the basic parameter which depends on the energy of the elementary process, from the maximum level of Energy (Planck Scale) to the energy level of our world (NOW). **During more than ten years (from 1979 to 1991), no one had realized that the energy threshold for the existence of the Superworld was strongly dependent on the “running” of the masses.**

This is now called: **the EGM effect** (from the initials of Evolution of Gaugino Masses) [7]. This effect produces a factor 700 in the threshold for the lightest supersymmetric particle. No one knows the value of the threshold Energy for the production of the lightest supersymmetric particle. The EGM effect lowers this value by a factor 700. Suppose that somebody would say that the **threshold is at 700 TeV; thanks to the EGM effect** this value is going to be **1 TeV**. In **Figure 5** the details in the high energy range indicate the existence of a GAP [8] between $E_{GUT} - E_{Planck}$. The GAP is the first evidence for the origin of the three Forces [QED (α_1) + QFD (α_2) + QCD (α_3)] being at E_{GUT} (the energy of the Grand Unified Theory) many orders of magnitude below E_{Planck} . This GAP suggests that the gravitational forces are generated before the other three Forces (QED, QFD, QCD).

Fig. 3.

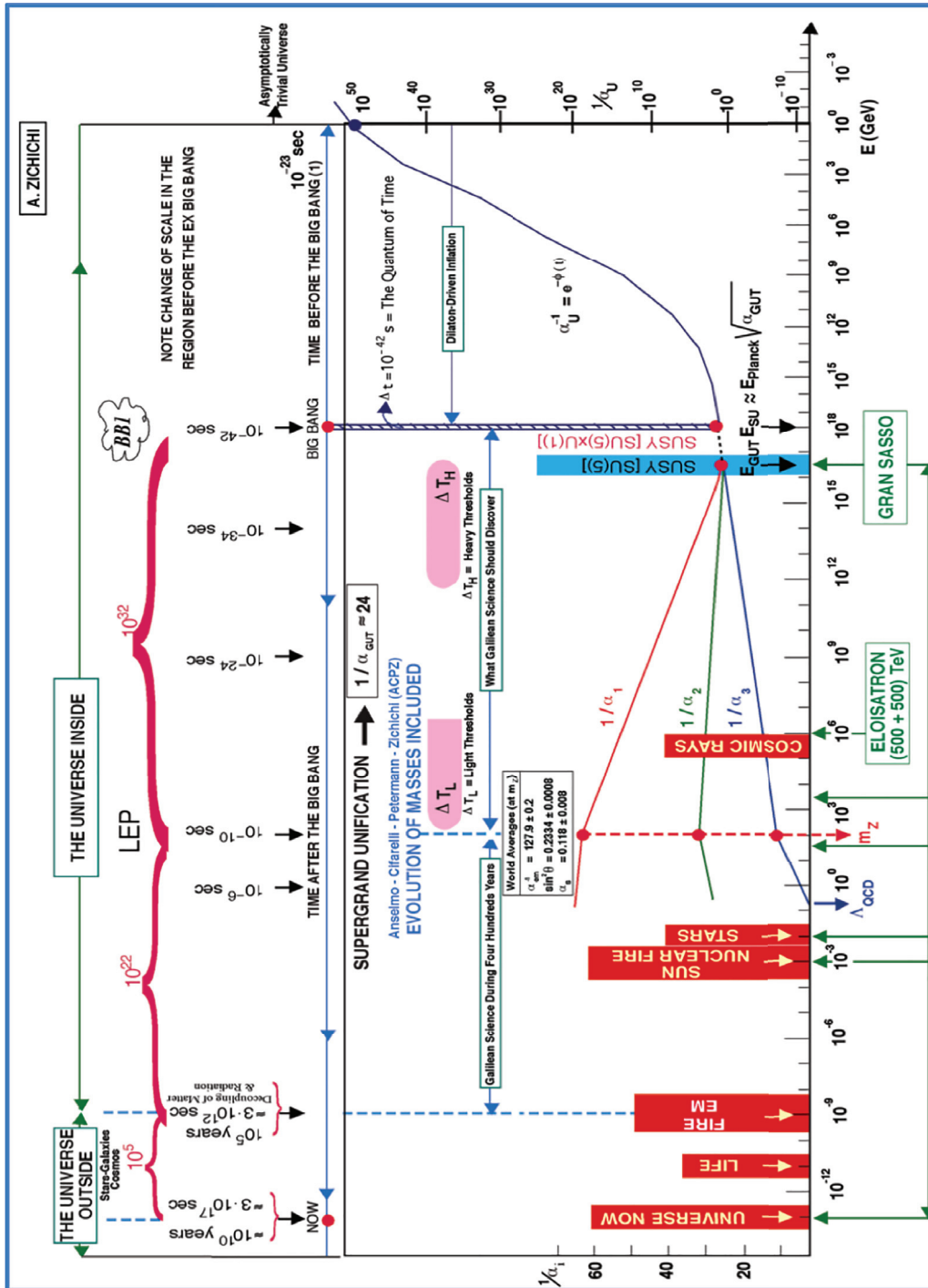


Fig. 4. – The present status of the unification of the three gauge couplings $\alpha_1\alpha_2\alpha_3$ is reported. This is the most accurate description of the unification whose mathematics is in Figure 3.

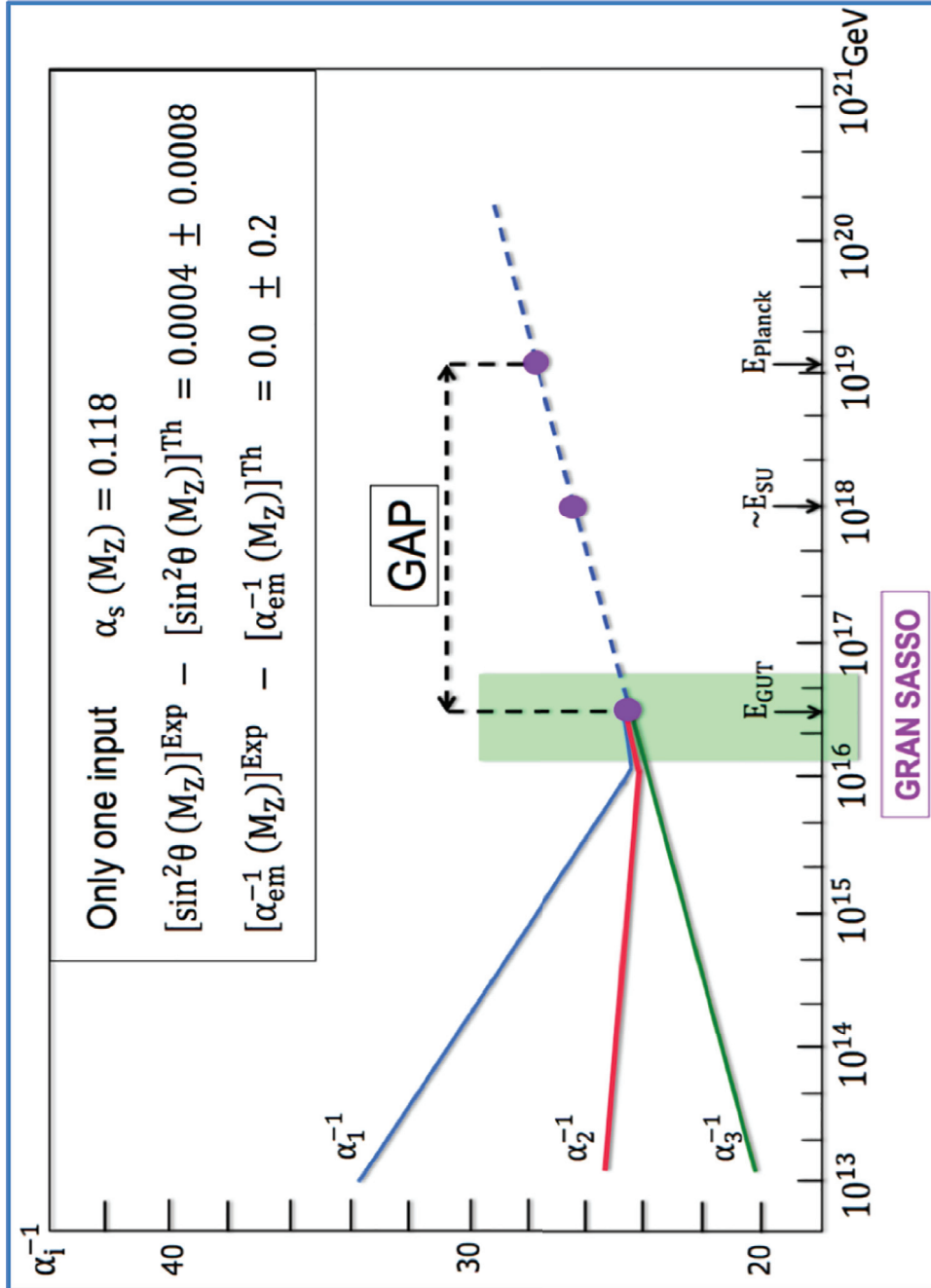


Fig. 5.

In the very first days of EPS the most famous physicist from Siberia Veniamin A. Sidorov came to Geneva, and he emphasized the relevance of Siberia being a member of USSR.

When I was visiting the Physics Institutes in Siberia (Novosibirsk) I realized that our colleagues in this part of USSR were, what we call in our Democratic Structures **Opposition**. In fact all fellows who had something to say against Moscow were immediately displaced in **Siberia**.

The Siberian fellow, Veniamin Sidorov, was a very active member of all our EPS actions. You can find him in the picture, many years after the EPS foundation.



The Holy Father, Pope John Paul II receiving in the Vatican the President of the European Physicists, A.Z., accompanied by the Council of the Presidency of the European Physical Society (EPS).

**The next meeting took place later
with forty-five members of EPS whose names follow:**

Dr. R.S. Pease, Abingdon	Prof. I.R.A.M. Hoogenboom, Utrecht
Prof. G.A. Smolensky, Leningrad	Prof. A. Zichichi, Geneva
Dr. T. Riste, Kjeller	Prof. V. Sidorov, Novosibirsk
Mrs. L.A. Thomas, Wembley	Mr. J. Béné, Geneva
Dr. P. Radványi, Orsay	Prof. G.-J. Béné, Geneva
Dr. B. Dreyfus, Grenoble	Prof. A. Lösche, Leipzig
Prof. K.K. Rebane, Tallin	Prof. S. Kapitza, Moscow
Prof. K.-H. Hausser, Heidelberg	Prof. G. Picozza, Rome
Prof. B. Robinson, Paris	Prof. G. Preparata, Geneva
Prof. W. Martienssen, Frankfurt/Main	Prof. M. Guenin, Geneva
Dr. L. Cohen, London	Prof. R. Scrimaglio, Frascati
Prof. E.R. Andrew, Nottingham	Dr. J. Fischer, Prague
Dr. F. James, Geneva	Prof. L. Kerwin, Ottawa
Prof. E.R. Dobbs, London	Prof. K. Hoselitz, UK
Dr. A. Strzalkowski, Cracow	Mrs. A. Hoselitz, UK
Prof. V. Goldenski, Moscow	Prof. J.M. Caraça, Lisbon
Prof. L.A. Thomas, Wembley	Dr. W.F. Druyvesteyn, Eindhoven
Acad. A. Datzef, Sofia	Prof. G. Eilenberger, Jülich
Prof. R.A. Ricci, Padua	Prof. E. Matthias, Berlin
Mr. E.N. Shaw, Geneva	Prof. A. Milojević, Belgrade
Prof. E.A. Müller, Geneva	Prof. C. Nordling, Uppsala
Prof. V. Ruuskanen, Jyväskylä	Dr. E.W. Otten, Geneva
Dr. C. Le Pair, Utrecht	



The roots of EPS are in our activity devoted to convince the most relevant fellows to be with us in order to give life to new Institution called **EPS**. A fellow who was of great help is **Peter Higgs** who in 1964 had the correct idea of solving the problem of allowing masses not to be zero. Nobody could predict that this problem needed many decades (1964–2012) to be experimentally proved to be in the Logic of Nature. During these decades the **Higgs–meson** became, thanks to Leon Lederman, the “**God–Particle**”.

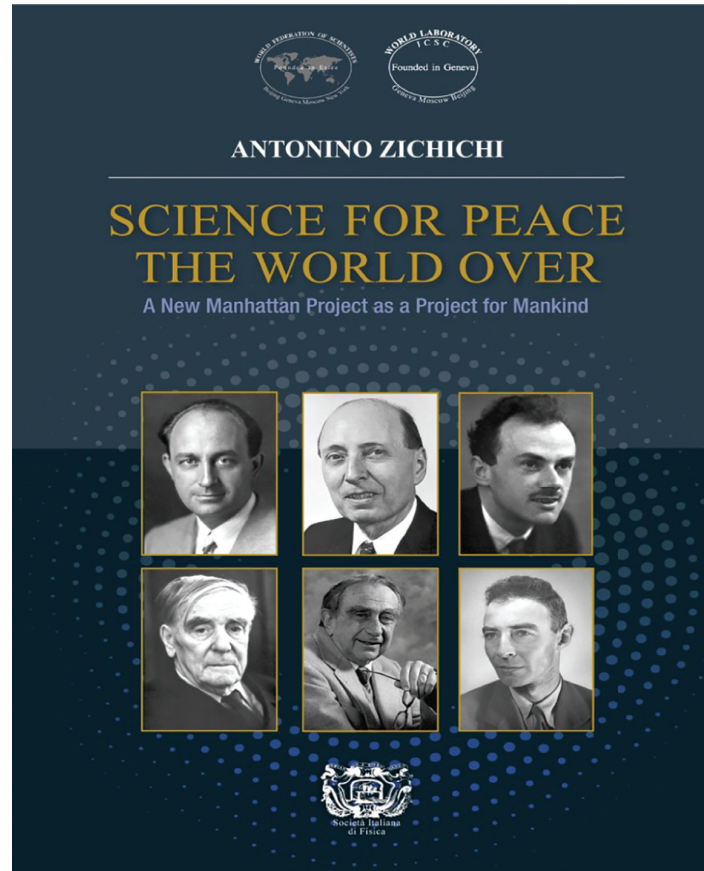


Fig. 6.

In the Physics steps we started with the proof that the first discovery (1967) of the Higgs meson was not correct (1969). Then 50 years of experimental attempts to find this meson produced the “**God-Particle**”.

The presence of Siberia, was not trivial. For the first time neither geographical nor political boundaries were taking into account for our fellows to be members of **EPS** (during those years USSR was not open at any Country to be added to USSR).

The Roots and the Future. – In the **1985 Geneva** meeting Gorbachev & Reagan adopted our **EPS** definition of Secret Laboratories. The **Enemy Number One** of Peace in the World are the Secret Laboratories. **Reagan & Gorbachev**: “We will open the Secret Laboratories”. **Now in 2018**, the Secret Laboratories are still **closed** but the project for East-West-North-South Scientific Collaboration is **going on**. Being physicists, we cannot limit ourselves to uttering words: We must propose a **Project: Science for Peace the World Over** [9].

The Future of EPS must be linked to Science for Peace the World Over which comes after The New Manhattan Project, also known as the Project for Mankind. Physics being the Queen of all Sciences we need to study the Whole of Our Knowledge, which allows the discovery of the **three Big Bangs**.

In Figure 7 we have a supersynthesis followed by few words in the Addendum.

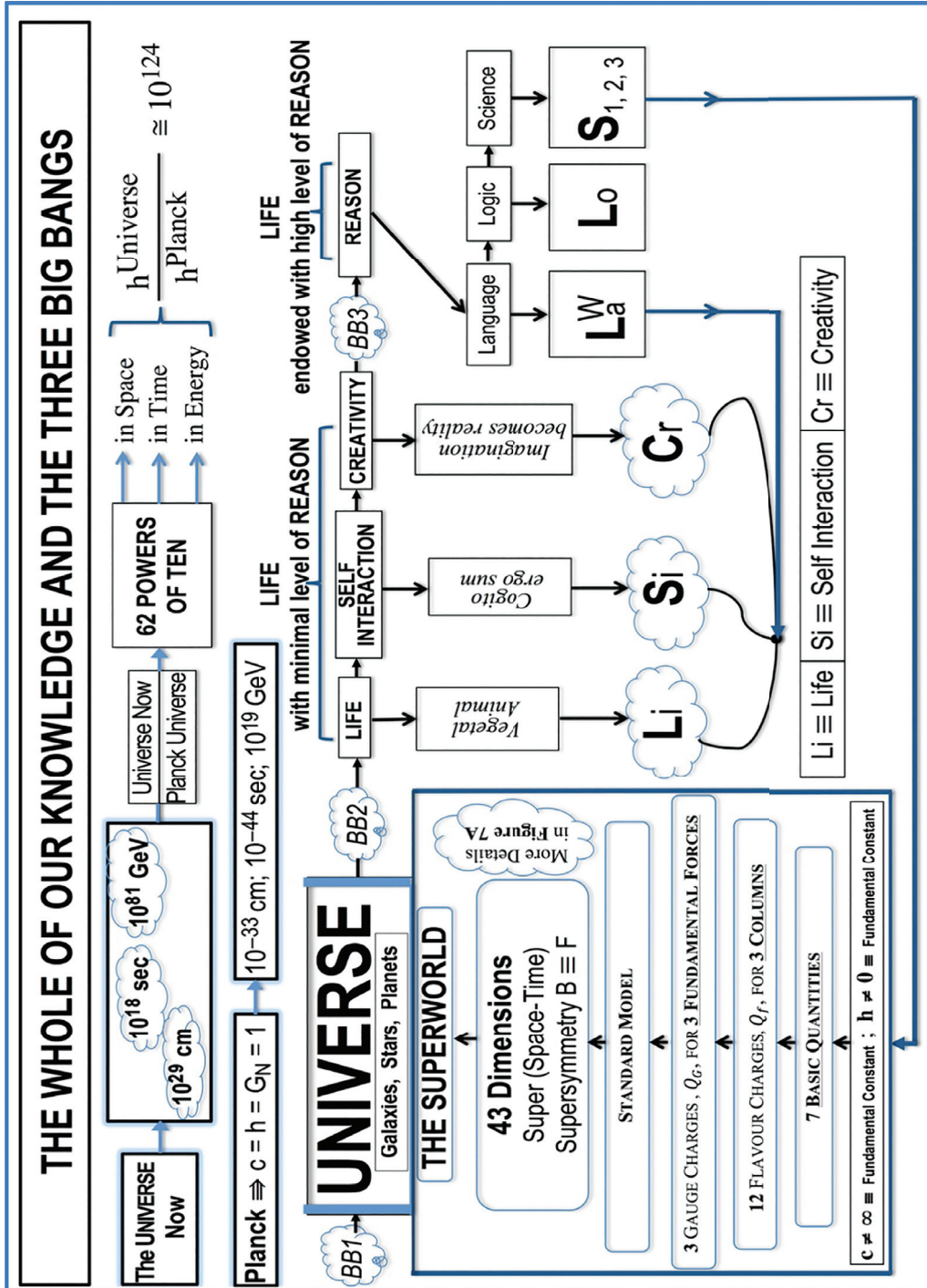


Fig. 7.

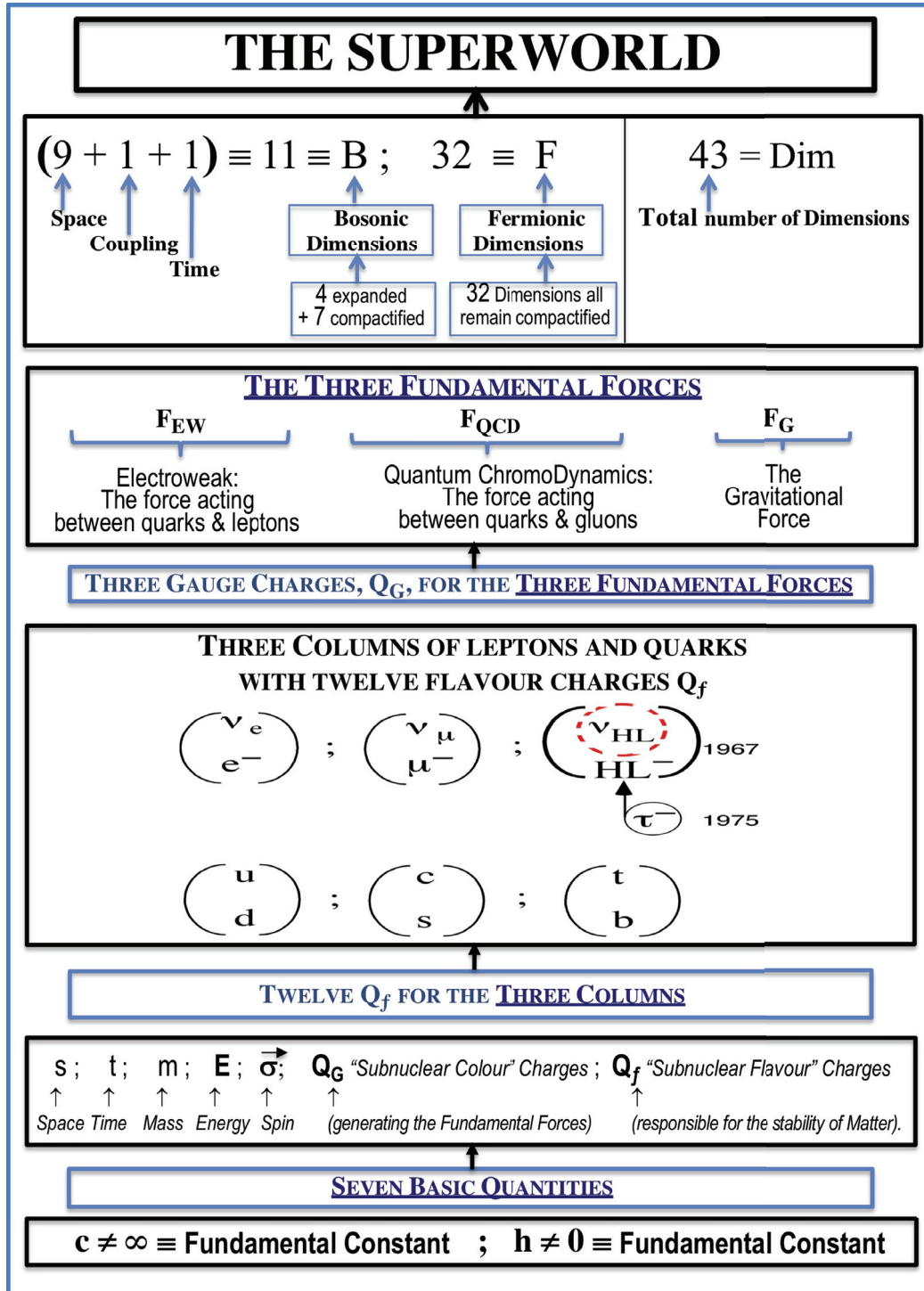




Fig. 7A.


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The EPS 50th Anniversary reminds me how much gratitude we must have towards Professor Blackett [10], whose actions to promote the Physics in Europe and all over the world must be highlighted.

Addendum: A Few Words On Figure 7.

The **First Big Bang**  is needed in order to describe how we go from the Vacuum to the Universe, made of inert matter.

The **Second Big Bang**  is needed in order to describe how we go from inert matter to matter endowed with life. This is being studied in many laboratories. Hundreds of scientists are fully engaged in studying what is called the “problem of minimal life”, i.e. how many pieces of inert matter are needed in order to produce the most elementary piece of “living matter”.

The **Third Big Bang**  is needed in order to describe how we go from matter endowed with life (and no Reason) to the most elementary form of living matter endowed with the privilege of also having Reason.

Please note that the term Reason is not referring to the most simple form of Reason needed by living matter in order to guarantee life. The term Reason is the form of Reason which produces **Language, Logic and Science**.

There are hundreds of thousands of forms of living matter (vegetal and animal, small and big) but **only one** form of living matter is able to invent “**Language**” (which gives rise to Permanent Collective Memory, better known as Written Language), “**Rigorous Theoretical Logic**” (known as Mathematics) and “**Rigorous Experimental Logic**” (known as first level Galilean Science).

The three Big Bangs are indicated in Figure 7, where the knowledge of the Universe plays a central role.

However, if the **Third Big Bang** had not occurred, none of us would have been able to discuss our problems and I could not have written this paper. The content of this Figure 7 includes many points I discussed with Professor Blackett when I was the youngest member of his group. Let me try to give a recollection of these interesting discussions.

It is thanks to Science that we have discovered the seven fundamental components needed to construct the real world as we know it and participate in it. These seven components are **space** (s), **time** (t), **spin** (σ), **mass** (m), **energy** (E), **gauge charge** (q^G) which generates the Fundamental Forces of Nature and **flavour charge** (q^f) which produces the stability of all fundamental particles, called quarks and leptons.

The seven components are the result of the three Big Bangs. The description of Figure 7 would take too much space. We will limit ourselves to the shortest possible remarks. The seven quantities must give rise to quarks and leptons which exist into three “Families”, which are also called Columns. This is the meaning of “three Columns” in Figure 7. The seven quantities must also generate the four Fundamental Forces. Notice in Figure 7 the Electromagnetic and the Weak Forces are **mixed** into the so called **Electroweak Force** (\mathbf{F}_{EW}). The reason being that these two forces start at the Fermi Energy from a mixed source.

The other **two forces** are, the Subnuclear Strong (\mathbf{F}_{QCD}) and the Gravitational Force (\mathbf{F}_G). All these forces should be unified into the Grand Unified Force (\mathbf{F}_{GU}).

All fundamental particles are not balls but spinning balls with semi-odd-integer value for their spin. All glues produced by the Fundamental Forces are also spinning balls, but with integral value for their spin. The spinning balls with semi-odd-integer value for their spin

$$\left(\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \dots\right)$$

are called “Fermions”, **F**. The spinning balls with integer value for their spin

$$(0, 1, 2, 3, 4, \dots)$$

are called “Bosons”, **B**. Fermions obey a statistical law totally different from the statistical law which have to obey the Bosons. The fermionic statistical law establishes that two identical Fermions cannot be in the same place. The bosonic statistical law establishes that in the same place can be any number of Bosons. The “same place” is a simple way to specify not only a “place” but a series of properties needed to identify an elementary particle.

The Superworld would be the result coming from a new Symmetry between Fermions and Bosons, ($B \equiv F$). This “**Supersymmetry**” should be valid not only for “particles” but also for Space and Time.

This is the origin of Superspace-Time with 43 dimensions, which are 11 bosonic and 32 fermionic. The 11 bosonic dimensions are 9 for Space, one for the fundamental coupling and one for Time. Out of the nine bosonic dimensions of Space, six remain compactified and three are expanded. The other bosonic dimension which is expanded is the Time dimension. The total number of bosonic expanded dimensions is therefore four.

In our world we have in fact four bosonic expanded dimensions: three for Space and one for Time. This is why we have so much **Space** and so much **Time** available. A volume of our Space needs three dimensions: height, width and length. The fact that all these three quantities can be measured with the same instrument, called meter, is the proof that our Space has three dimensions. The dimensions needed for Time is only one and is measured with a clock (Einstein *dixit*).


Along the Time dimension there are phenomena for which the two arrows of Time (from past to future and from future to past) are allowed, thus obeying to the Wigner theorem. Others phenomena are not obeying the Wigner theorem. In synthesis: only some “elementary processes” can go in the two opposite directions along the Time axis without changing any of their properties.


The other seven bosonic dimensions remain compactified. As said already, one of these corresponds to the fundamental coupling of the Grand Unified Force (F_{GU}) from which all other forces (F_{EW} ; F_{QCD} ; F_G) are generated.

In addition to the 11 bosonic dimensions there are 32 fermionic dimensions. These remain all compactified. As mentioned before, the bosonic and fermionic dimensions are the basis of the Superspace with a total of 43 dimensions.

An important property distinguishes the fermionic dimensions from the bosonic dimensions.

In the Superspace with bosonic dimensions it is possible to go in one direction or in the opposite direction, as we do in everyday life along the three expanded dimensions of Space. In the Superspace with fermionic dimensions this is impossible. The Superspace with 43 dimensions, and all their properties, which we have briefly described, are needed

for everything that refers to inert matter. Life extends beyond the confines of inert matter. When we introduce life into a description of the world, the first problem to solve, as already mentioned, is the transition called Big Bang Two  from inert matter to living matter.

There are very many forms of matter with life (vegetal and animal) and with very low levels of Reason. The number of all these forms of life is in the range of a million. Despite this enormous number, only one form of living matter has the privilege of being endowed with the extraordinary property of a high level of Reason. As shown in Figure 7 the Third Big Bang  is needed in order to have the transition to this form of matter.

It is thanks to the existence of matter with high level Reason that we have been able to discover **Language, Logic and Science**. Language has produced “Permanent Collective Memory” (PCM) better known as “writing”. With logic we mean Rigorous Theoretical Logic, better known as Mathematics. There is another form of Rigorous Logic, which needs experimental reproducibility, and it is known as Science. **Two** more details.

A Note on the Speed of Light.

In **Figure 7** the **letter c** indicates the speed of light which is a fundamental constant of Nature and it **is not infinite** (∞) as believed to be for millennia. The first fellow who attempted to measure the speed of light is Galilei in the sixteenth Century. He would have succeeded to prove that the speed of light was not ∞ if it would have been thirty times the speed of sound.

The speed of light is not infinite but a **million times greater than that of sound**. This is why Galilei was unable to measure it. Galilei had at his disposition the distance between two hills in the Tuscan countryside, in other words just a few kilometres. We had to wait Ole C. Rømer (1644–1710), who used Jupiter’s *Io* as the cosmic lantern, and the orbital velocity of the Earth. This gave him the “million times” factor that Galilei did not have. Not only was *Io* discovered by Galilei, but the regularity in the light signals emitted by the moons of Jupiter had led Galilei to propose using it as a “cosmic clock”. And it was by **using Galilei’s “cosmic clock”, and the speed by which the Earth moved**, away from and closer to Jupiter, due to its orbital motion, that **Rømer succeeded in demonstrating that the speed of light is not infinite** measuring for the first time after Galileo Galilei, its finite value, as Galilei was expecting.

A Note on the Planck’s Action.

The other detail in the same box of **Figure 7** refers to the quantity h , which is the other fundamental quantity of Nature: **action**. For millennia this quantity was believed to be as small as wanted, including zero. Planck proved, in 1900, that the smallest quantity of action cannot be zero, $h \neq 0$, but greater or equal to the quantity now called Planck’s action. If I give to a friend of mine a bit of energy for a small interval of time, this is a small action which corresponds to a very high number – **billions of billions of billions** – of the smallest amount of elementary action, i.e. the **Planck’s action**. **Let us calculate** the energy needed to bring **one kilogramme of mass** up by one **meter**. If this energy is multiplied by the Time of **one second** the result is a quantity of action equal to **ten million of billion billion billion times the Planck’s action**. A few other details for Figure 7.

Li corresponds to all forms of matter endowed with Life, vegetal and animal.

Si indicates all interactions that matter can have with life and with a minimum level of Reason.

Cr stands for Creativity which is when even the lowest level of imagination becomes reality.

L_a^W is Written Language; **Lo** is the Theoretical Logic (Mathematics); Science – as said several times – is Rigorous Experimental Logic. Science has three levels, this is the meaning of **S_{1,2,3}**.

The 1st level corresponds to reproducible experiments in a Laboratory: for example, the discovery of Antimatter [11].

The 2nd level corresponds to observations with no possibility of intervention: example, the study of evolution of Stars.

The 3rd level is when something happens only once: example, the first Big Bang. The 3rd level seems to be in contradiction with reproducibility and could seem in contradiction with the meaning of Science.

All three Big Bangs are Science because their description can never be in contradiction with what has been discovered at the 1st level of Science. In Figure 7 the Planck length (10^{-33} cm), the Planck time (10^{-44} sec) and the Planck energy (10^{19} GeV) are given. **These quantities have been discovered by Planck in 1900** when he took as fundamental units the values of the fundamental constants of Nature (for simplicity we do not include k):

- 1) the speed of light;
- 2) the value of the Planck action;
- 3) the Newton constant.

When the radius of the Universe (10^{29} cm), the age of the Universe (10^{18} sec) and the energy of the Universe (10^{81} GeV) are divided by the Planck length, the Planck time and the Planck energy the result is 10^{62} :

$$\frac{10^{29}\text{cm}}{10^{-33}\text{cm}} = \frac{10^{18}\text{sec}}{10^{-44}\text{sec}} = \frac{10^{81}\text{GeV}}{10^{19}\text{GeV}} = 10^{62}.$$

These are very meaningful big ratios linked to our world. A statement concerning the biggest number. The biggest number comes out when the action of the Universe is divided by the Planck action. This ratio is the number “**one**” followed by hundred twenty-four zeros: 10^{124} , as reported in Figure 7.

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