

MY PERSONAL EXPERIENCE ON THE SCIENTIFIC LEGACY OF THE 20th CENTURY

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1. Introductory Remarks Concerning the ‘Convictions Spread by Modern Culture’

Let me, first of all, express my gratitude to our Chancellor, Monsignor Marcelo Sánchez Sorondo, Professors Werner Arber and Jürgen Mittelstrass, for having organised this extremely interesting and ‘up-to-date’ series of plenary sessions of our Academy, dedicated to the *Scientific Legacy of the 20th Century*.

1st point. The Scientific Legacy of the 20th Century cannot be independent from and must be coupled with the Culture of our Time [1].

2nd point. This Culture is defined as being ‘modern’ but in fact it is pre-Aristotelic [2]. Proof: neither Rigorous Logic nor Science are part of the Culture of our Time.

Let me recall a statement by H.H. Benedict XVI, concerning the Culture of our Time. The Pope has pointed out that it is necessary to speak about the *elements that challenge the convictions spread by Modern Culture*. The most important of these ‘convictions’ is the link between Science and Faith. Here comes my second point: namely the fact that, in the Culture of our Time, Rigorous Logic and Science are absent. It is generally believed that the reason why people have Faith is because the great public knows little, very little, about Rigorous Logic and Science.

Modern Culture maintains that if people knew more about Mathematics and Physics which, according to Enrico Fermi, is the fulcrum of all sciences, people would realise that Faith has nothing to do with either Logic or Science and that Faith is in contradiction with the great achievements of Mathematics and Physics. A widespread conviction of Modern Culture is that Atheism is the result of the great achievements in mathematical rigour and in Physics. If our so-called Modern Culture were consistent in its reasoning, it would have to recognise the fact that a rigorous analysis of what Atheism is all about shows that Atheism is an act of Faith about nothing (see Appendix 1).

Here comes my ‘personal experience’, based on what I have done in Physics. The result is that what I have done is perfectly consistent with all other achievements in the fundamental search for the existence of the ‘Logic of Nature’. This is what we have been doing since Galileo Galilei, the father of the 1st Level of Science (the three levels of Science are discussed in Ap-

pendix 2). The results obtained in 1st Level Science show that these results were obtained in a totally unexpected way, i.e.: no one had been able to predict these discoveries. The list of these discoveries is impressive as I have already reported in previous lectures ([3], see also Appendix 5.3). We call these achievements UEECs, which stands for Unexpected Events with Enormous Consequences. What I have done further confirms the existence of UEEC phenomena, which started to be discovered by the father of the 1st Level of Science, Galileo Galilei. Let me show a synthesis of achievements in Physics from Galilei to the first half of the 20th Century (Figures 1 and 2).

“UEEC” TOTALLY UNEXPECTED DISCOVERIES FROM GALILEI TO FERMI-DIRAC, THE “STRANGE” PARTICLES AND THE YUKAWA GOLDMINE	
<i>I</i>	Galileo Galilei: $F = mg$.
<i>II</i>	Newton: $F = G \frac{m_1 \cdot m_2}{R_{12}^2}$
<i>III</i>	Maxwell: the unification of electricity, magnetism and optical phenomena, which allows to conclude that light is a vibration of the EM field.
<i>IV</i>	Becquerell: radioactivity.
<i>V</i>	Planck: $h \neq 0$. The quantum nature of the World.
<i>VI</i>	Lorentz: Space and Time cannot both be real.
<i>VII</i>	Einstein: the existence of time-like and space-like worlds. Only in the time-like world, simultaneity does not change, with changing observer.
<i>VIII</i>	Einstein: the photon.
<i>IX</i>	Weyl: Gauge Invariance.
<i>X</i>	Bohr: the structure of the atom.
<i>XI</i>	de Broglie: wave nature of particles.
<i>XII</i>	Schrödinger: wave function, and its probabilistic interpretation (Born).
<i>XIII</i>	Rutherford: the nucleus.
<i>XIV</i>	Hess: cosmic rays.
<i>XV</i>	Einstein: the Space-Time curvature.
<i>XVI</i>	Von Neumann: the proof that Quantum Mechanics is self consistent (no contradictions).
<i>XVII</i>	Pauli: the Exclusion Principle.
<i>XVIII</i>	Heisenberg: the Uncertainty Principle.

Figure 1.

<i>XXIX</i>	Dirac discovers his equation, which opens new horizons, including the existence of the antiworld.
<i>XX</i>	Chadwick: the neutron.
<i>XXI</i>	Wigner: Time Reversal Invariance (T).
<i>XXII</i>	Majorana: relativistic invariance allows not only spin $\frac{1}{2}$, as it is the case for the electron, but any spin value.
<i>XXIII</i>	Majorana: uncharged particles with spin $\frac{1}{2}$ identical to their antiparticles are allowed by relativistic invariance. These particles are now called “Majorana fermions”.
<i>XXIV</i>	Fermi–Dirac and Bose–Einstein discover two completely different statistical laws.
<i>XXV</i>	Other Invariance Laws: Charge conjugation (Weyl and Dirac); Parity (Wigner); CPT (Pauli).
<i>XXVI</i>	The neutrino (Pauli, Fermi).
<i>XXVII</i>	Fermi: weak forces.
<i>XXVIII</i>	The Stars are “nuclear-fusion” candles (Fermi, Bethe).
<i>XXIX</i>	Von Neumann: electronic computing.
<i>XXX</i>	The sequence of unexpected Fermi discoveries: Fermi-coupling, Fermi-gas, Fermi-momentum, Fermi-temperature, Fermi-surface, Fermi-transition, Fermi-length (plus the other three quoted above: XXIV, XXVI, XXVII).
<i>XXXI</i>	The “strange particles” are discovered in the Blackett Lab.
<i>XXXII</i>	<p>The Yukawa goldmine. Let me devote some attention to the discussion of UEEC events in nuclear physics (i.e., The Yukawa Goldmine).</p> <p style="text-align: center;"><i>Nuclear Physics and UEEC events.</i></p> <p>It is considered standard wisdom that nuclear physics is based on perfectly sound theoretical predictions. People forget the impressive series of UEEC events discovered in what I have decided to call the “Yukawa goldmine” [4]. Let me quote just three of them:</p> <ol style="list-style-type: none"> 1 The first experimental evidence for a cosmic ray particle believed to be the Yukawa meson was a lepton: the muon. 2 The decay-chain: $\pi \rightarrow \mu \rightarrow e$ was found to break the symmetry laws of Parity and Charge Conjugation. 3 The intrinsic structure of the Yukawa particle was found to be governed by a new fundamental force of Nature, Quantum Chromodynamics: QCD. <p>As you know 2007 was the centenary of the birth of Hideki Yukawa, the father of theoretical nuclear physics [4]. In 1935 the existence of a particle, with mass intermediate (this is the origin of “mesotron” now “meson”) between the light electron, m_e, and the heavy nucleon (proton or neutron), m_N, was proposed by Yukawa [5]. This intermediate mass value was deduced by Yukawa from the range of the nuclear forces. Contrary to the general wisdom of the time, Yukawa was convinced that the particles known (electrons, protons, neutrons and photons), could not explain how protons and neutrons are bound into the extremely small dimensions of a nucleus.</p>
<i>XXXIII</i>	The “Majorana fermions” give rise to a sequence of unexpected discoveries not only in the grand unification of all fundamental forces but also in the physics of condensed matter, such as: Majorana spin-flip and ultra-low T physics, topological insulators, Majorana liquids and fermion fractionalization, Majorana fermions in tunable semiconductors, Majorana fermions and topological phase transitions.

Figure 2.

I have included the invention of electronic computers by Von Neumann (XXIX), which no one could have imagined at the beginning of the 20th Century. Point no. XXX refers to the impressive list of Fermi discoveries: once again, all totally unexpected.

THE SECOND HALF OF THE 20TH CENTURY	
XXXIV	The Subnuclear World.
XXXV	The Standard Model and Beyond.
XXXVI	The Superworld.

Figure 3.

The UEECs of the second half of the 20th Century (Figure 3) are grouped into 3 classes:

- one is the ‘Subnuclear World’
- the second is the ‘Standard Model and Beyond’
- the third is the ‘Superworld’.

The existence of the Subnuclear World and the Standard Model are strictly correlated. The third is the frontier of our knowledge which exists as a fascinating mathematical structure, but lacks Galilean experimental proof (Appendix 3).

The reason why no one is able to predict what is discovered in fundamental scientific research is inherent in the fact that the Author of the Logic which governs the world, from its most elementary structures to the frontier of the cosmos, is smarter than us all: philosophers, thinkers, mathematicians, physicists, artistic leaders, musicians, no one excluded.

The Author of the Logic of Nature being smarter than us all, the only way to learn more about the Fundamental Logic is to perform experiments. The most advanced experiment in the frontier of our Physics is, today, the Quark-Gluon-Coloured-World (QGCW) [6] project whose purpose is to understand how the world was one-tenth of a nanosecond (10^{-10} sec.) after the Big Bang. No philosopher, no mathematician, no physicist can tell us if, at that moment, the world was as we think it could have been, i.e.: obeying the Supersymmetry Law which establishes that Fermions and Bosons must be exactly equivalent, i.e.:

$$F \equiv B.$$

This supersymmetry law generates the Superworld. Details about the reasons why the Superworld is needed are in Appendix 3.4. From the Superworld, after 20 billion years, here we are with the world in 4 dimensions (3 for space, one for time, Figure 15a), while the Superworld has 43 dimensions (Figure 15b). These two Figures are on page 21. Where the ashes of the Superworld might be is in Appendix 3.5. The point I want to emphasize is that no one can tell us what will be discovered at CERN with the LHC, the Large Hadron Collider, the world's most powerful collider, which will recreate the conditions the world was in at $\Delta t = 10^{-10}$ sec. after the Big Bang. No one can tell us if the Superworld was there at that time. Only the experimental results will allow us to know if the reasons why the Superworld is needed are correct and the corresponding mathematics do belong to the Logic of Nature that we are trying to decipher.

After these long introductory remarks, I will now devote the last part of this lecture to my activity, which is my contribution to the confirmation that UEEC phenomena exist and represent the proof that the Author of the Logic of Nature is smarter than us all. Here is my personal experience.

2. My Scientific Testimony

A few examples I have been involved in are reported in Figure 4.

- ① **The 3rd lepton, HL** (now called τ) with its own neutrino, ν_{HL} (now called ν_τ),
despite the abundance of neutrinos: ν_e and ν_μ .
- ② **Antimatter**
despite S-matrix and C, P, CP, T breakings.
- ③ **Nucleon Time-like EM structure**
despite S-matrix
- ④ **No quarks** in violent (pp) collisions
despite scaling.
- ⑤ **Meson mixings**
 $\theta_V \neq \theta_{PS} : (51^\circ) \neq (10^\circ) \neq 0$ *despite $SU(3)_{uds}$.*
- ⑥ **Effective energy:** the Gribov QCD-light
despite QCD-confinement.
- ⑦ **The running of $\alpha_1 \alpha_2 \alpha_3$ versus energy:**
the EGM effect, the GAP between E_{GUT} and E_{SU} , and the absence of the Platonic straight line convergence.

Figure 4.

I will only discuss four points: 1, 2, 6 and 7.

Point 1

The Third Lepton, and the other unexpected events in Electroweak Interactions are illustrated in Figure 5.

Note that for the Electroweak force, Nature has not chosen the simplest way out $SU(2)$, but unexpectedly $SU(2) \times U(1)$.

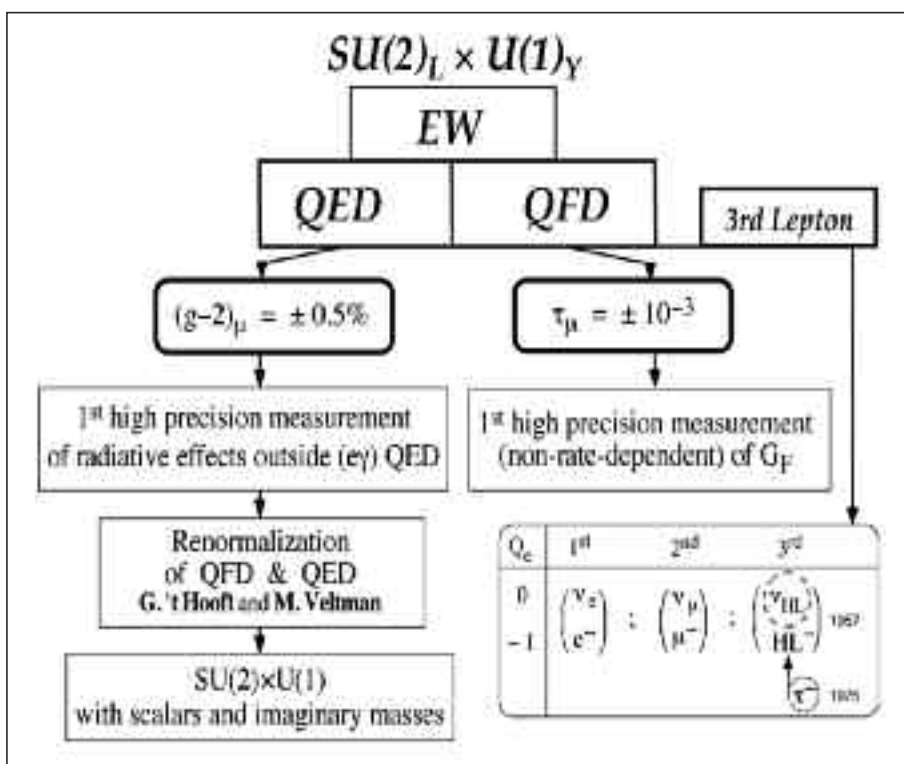


Figure 5.

Point 2

The problem of understanding the difference between mass and matter is illustrated in Figure 6. The incredible series of events which originated with the problem of understanding the stability of matter is shown in Figure 7, together with the unexpected violation of the Symmetry Operators (C, P, T, CP) and the discovery of Matter-Antimatter Symmetry.

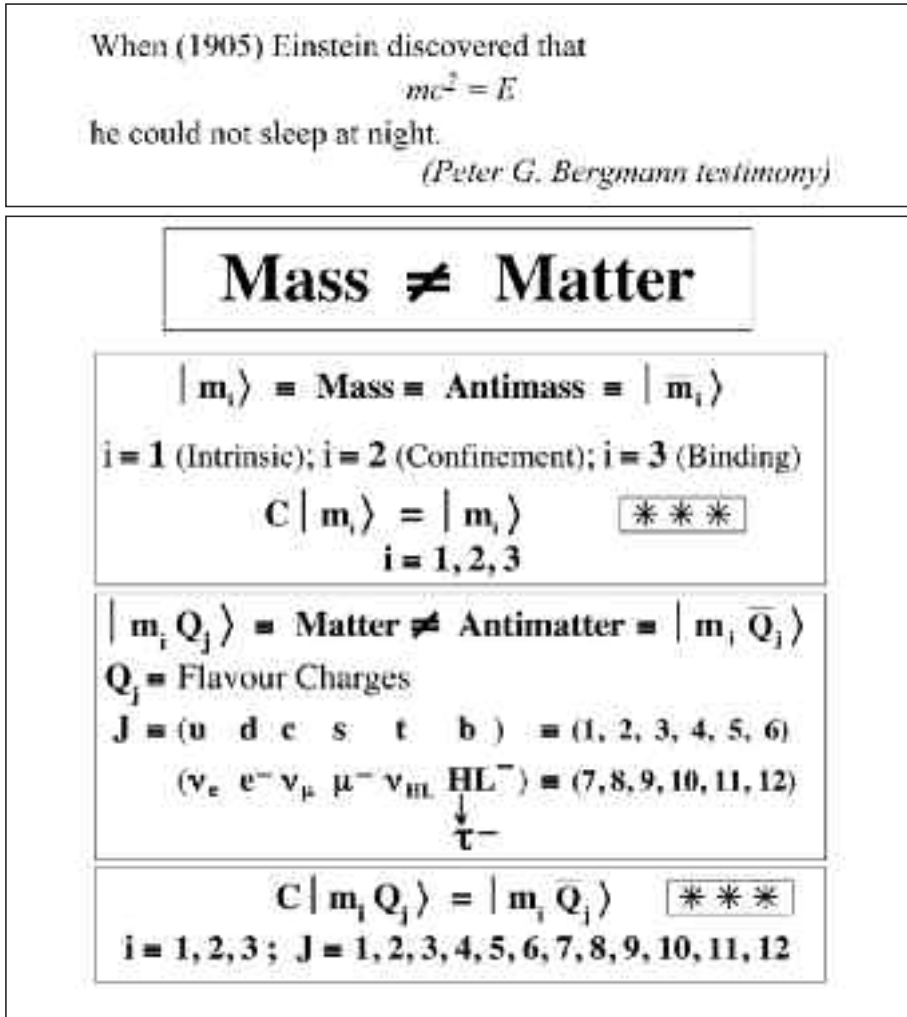


Figure 6.

Figure 7 shows seven decades of developments, which started from the antielectron and C-invariance and brought us to the discovery of nuclear antimatter and to the unification of all gauge forces with a series of unexpected discoveries.

**THE INCREDIBLE STORY
TO UNDERSTAND THE ORIGIN OF THE STABILITY OF MATTER
SEVEN DECADES FROM THE ANTIELECTRON TO ANTIMATTER
AND THE UNIFICATION OF ALL GAUGE FORCES**

• **The validity of C invariance from 1927 to 1957.**

After the discovery by Thomson in 1897 of the first example of an elementary particle, the Electron, it took the genius of Dirac to theoretically discover the Antielectron thirty years after Thomson.

- 1927** → Dirac equation [7]; the existence of the antielectron is, soon after, theoretically predicted. Only a few years were needed, after Dirac's theoretical discovery, to experimentally confirm (Anderson, Blackett and Occhialini [8]) the existence of the Dirac antielectron.
- 1930-1957** → **Discovery of the C operator** [(charge conjugation) H. Weyl and P.A.M. Dirac [9]]; discovery of the P Symmetry Operator [E.P. Wigner, G.C. Wick and A.S. Wightman [10, 11]]; discovery of the T operator (time reversal) [E.P. Wigner, J. Schwinger and J.S. Bell [12, 13, 14, 15]]; discovery of the CPT Symmetry Operator from RQFT (1955-57) [16].
- 1927-1957** → Validity of C invariance: e^+ [8]; \bar{p} [17]; \bar{n} [18]; $K_S^0 \rightarrow 3\pi$ [19] but see LOY [20].
- **The new era starts: C ≠ ; P ≠ ; CP ≠ (*)**.
- 1956** → Lee & Yang P ≠ ; C ≠ [21].
- 1957** → Before the experimental discovery of P ≠ & C ≠, Lee, Oehme, Yang (LOY) [20] point out that the existence of the second neutral K-meson, $K_S^0 \rightarrow 3\pi$, is proof neither of C invariance nor of CP invariance. Flavour antiflavour mixing does not imply CP invariance.
- 1957** → C.S. Wu et al. P ≠ ; C ≠ [22]; CP ok [23].
- 1964** → $K_L^0 \rightarrow 2\pi = K_L^0$: CP ≠ [24].
- 1947-1967** → QED divergences & Landau poles.
- 1950-1970** → The crisis of RQFT & the triumph of S-matrix theory (i.e. the negation of RQFT).
- 1965** → Nuclear antimatter is (experimentally) discovered [25]. See also [26].
- 1968** → The discovery [27] at SLAC of Scaling (free quarks inside a nucleon at very high q^2) but in violent (pp) collisions no free quarks at the ISR are experimentally found [28]. Theorists consider Scaling as being evidence for RQFT not to be able to describe the Physics of Strong Interactions. The only exception is G. 't Hooft who discovered in 1971 that the β -function has negative sign for non-Abelian theories [29].
- 1971-1973** → $\beta = -$; 't Hooft; Politzer; Gross & Wilczek. The discovery of **non-Abelian** gauge theories. Asymptotic freedom in the interaction between quarks and gluons [29].
- 1974** → All gauge couplings α_1 α_2 α_3 run with q^2 but they do not converge towards a unique point.
- 1979** → A.P. & A.Z. point out that the new degree of freedom due to SUSY allows the three couplings α_1 α_2 α_3 , **to converge towards a unique point** [30].
- 1980** → QCD has a "hidden" side: the multitude of final states for each pair of interacting particles: (e^+e^- ; $p\bar{p}$; $\pi\pi$; Kp ; νp ; pp ; etc.) The introduction of the Effective Energy allows to discover the Universality properties [31] in the multihadronic final states.
- 1992** → All gauge couplings converge towards a unique point at the gauge unification energy: $E_{GU} \approx 10^{16}$ GeV with $\alpha_{GU} \approx 1/24$ [32, 33].
- 1994** → The Gap [34] between E_{GU} & the String Unification Energy: $E_{SU} \approx E_{Planck}$.
- 1995** → **CPT loses its foundations at the Planck scale (T.D. Lee)** [35].
- 1995-1999** → **No CPT theorem from M-theory (B. Greene)** [36].
- 1995-2000** → A.Z. points out the need for new experiments to establish if matter-antimatter symmetry or asymmetry are at work.

(*) The symbol ≠ stands for "Symmetry Breakdown".

Figure 7.

Point 6

The non-Abelian nature of the Interaction describing quarks, gluons and the Effective Energy with the set of unexpected discoveries is illustrated in Figure 8.

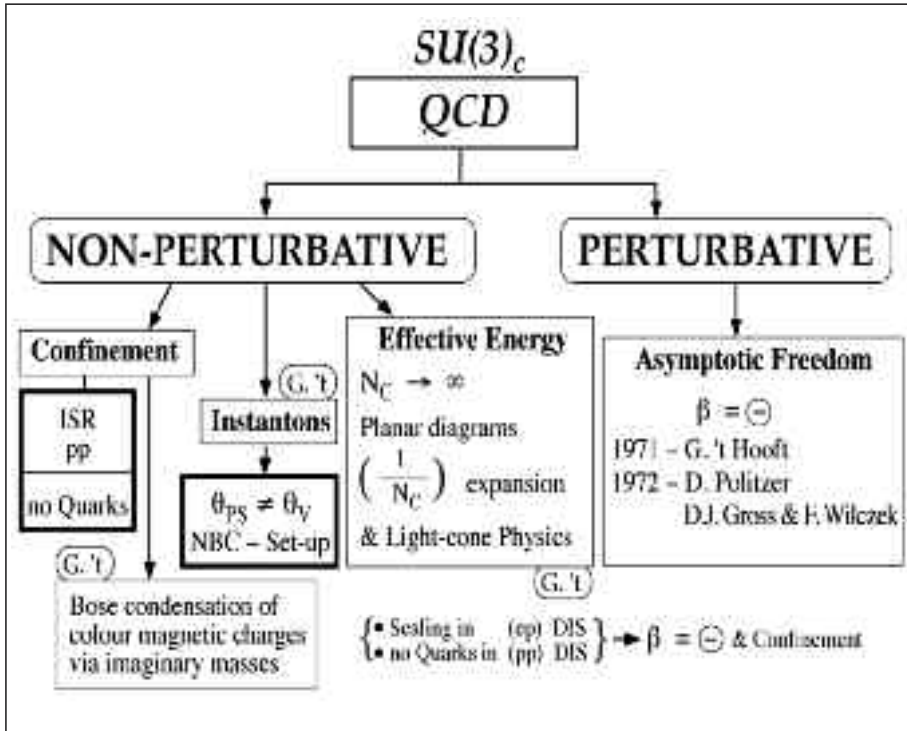


Figure 8.

Point 7

The Unification of all Forces and the Supersymmetry threshold with its problems are reported in Figures 9 and 10 (see pp. 359–360) respectively.

Figure 10 illustrates the EGM effect which lowers by a factor 700 the threshold for the production of the lightest superparticle.

The mathematical formalism used to obtain the results shown in Figures 9 and 10 is a system of three differential non-linear equations (shown in Figure 11) describing how the gauge couplings

$$\alpha_i, \alpha_j \text{ (with } i = 1, 2, 3; \text{ and } j = 1, 2, 3 \text{ but } i \neq j),$$

vary with ‘ μ ’, the basic parameter which depends on the energy of a given elementary process.

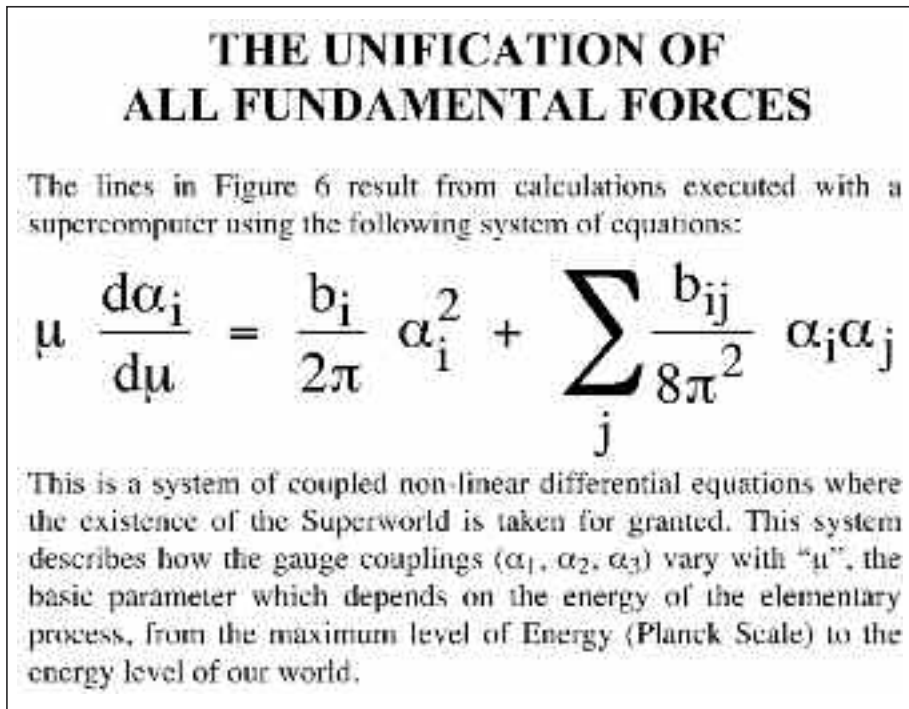


Figure 11.

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). To compute the energy threshold using only the ‘running’ of the gauge couplings ($\alpha_1, \alpha_2, \alpha_3$) corresponds to neglecting nearly three orders of magnitude in the energy threshold for the discovery of the first particle (the lightest) of the Superworld [33], as illustrated in Figure 10.

A different way to describe how the gauge couplings $\alpha_1, \alpha_2, \alpha_3$ vary with energy is reported in Figure 12 (see p. 361). The simplest way to get GUT (the point where all fundamental forces are together: Grand Unification Theory) would be the straight line. But the real world does not follow this ‘platonic’ straight line. The sequence of points (the big red points), in steps of 100 GeV, is very different from the Platonic line (dotted blue points). The way nature goes is reported by the sequence of the big red points which are the result of the mathematics reported in Figure 11.

3. Where we are in Understanding the Logic of Nature

My scientific testimony, synthetically discussed in the previous paragraphs, is a contribution to where we are now in understanding the Logic of Nature. This is illustrated in Figures 13-17 and 18 (see p. 362).

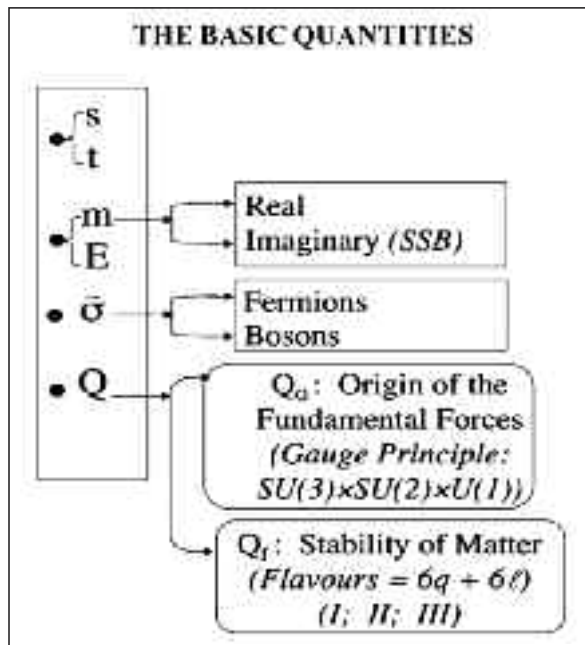


Figure 13.

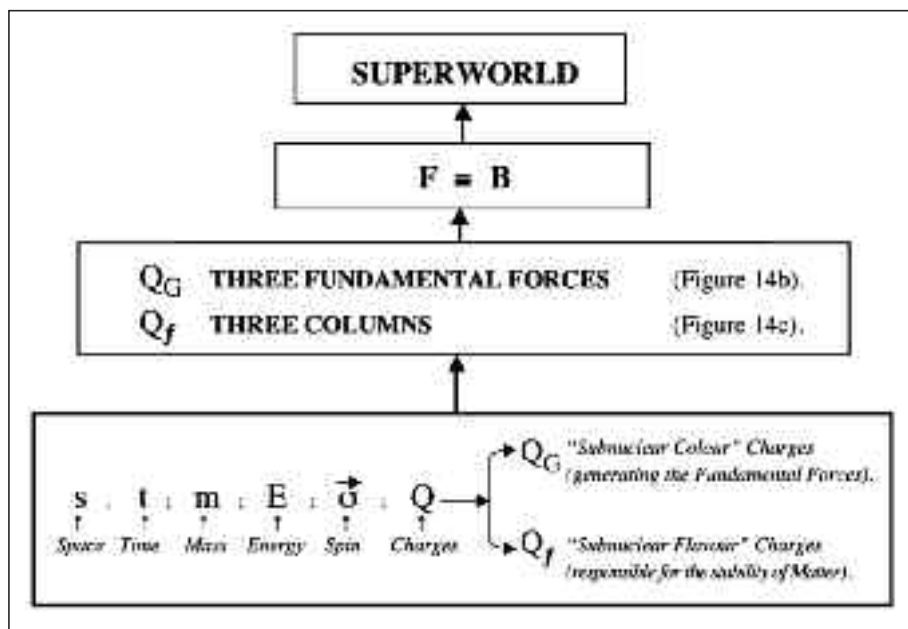


Figure 14a.

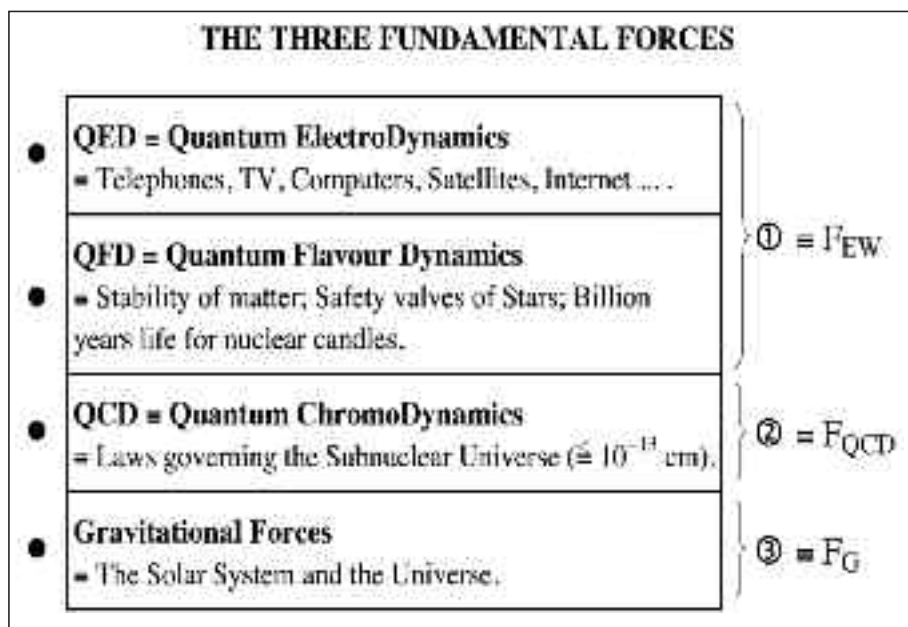


Figure 14b.

THE THREE COLUMNS		
$\begin{pmatrix} \nu_e \\ e^- \end{pmatrix}$	$\begin{pmatrix} \nu_\mu \\ \mu^- \end{pmatrix}$	$\begin{pmatrix} \nu_\tau \\ \tau^- \end{pmatrix}$
$\begin{pmatrix} u \\ d \end{pmatrix}$	$\begin{pmatrix} c \\ s \end{pmatrix}$	$\begin{pmatrix} t \\ b \end{pmatrix}$
I	II	III

Figure 14c.

$s, t, m, E, \vec{\sigma}, Q_G, Q_f$		$c \neq \infty$ $\hbar \neq 0$
I; II; III	$F_{EW}; F_{QCD}; F_G \rightarrow F_{GU}$	
$B \equiv F$ (Superworld)		
$[9 + 1 + 1] \equiv 11 \equiv B ; 32 \equiv F$ $\begin{matrix} \uparrow & \uparrow & \uparrow \\ \text{Space} & \text{Couplings} & \text{Time} \end{matrix}$		$43 \equiv \text{Dim}$

Figure 14d.

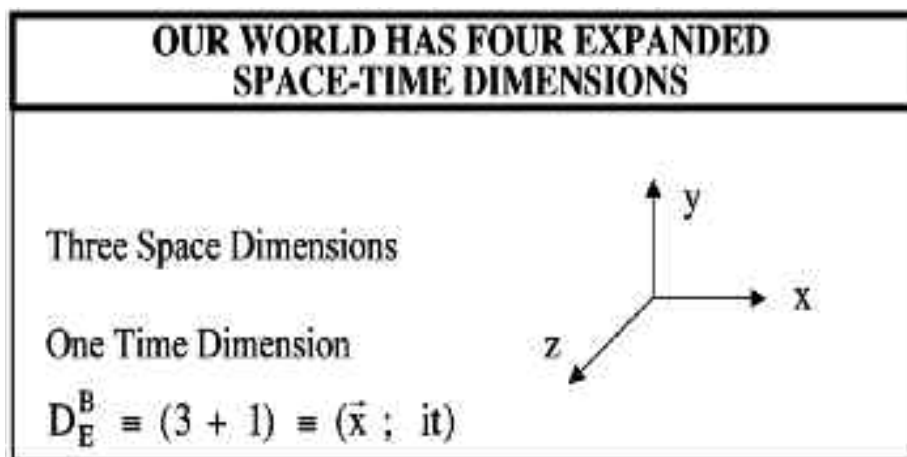


Figure 15a.

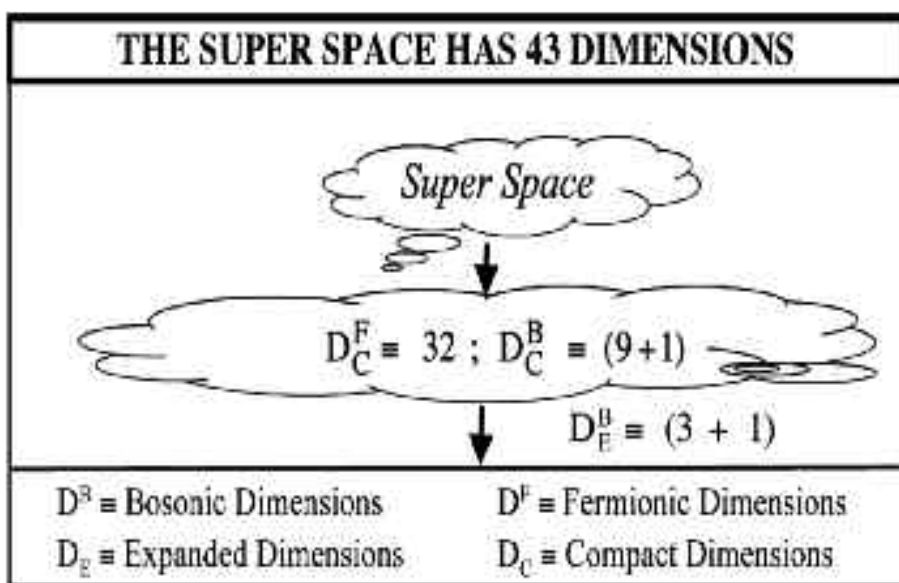


Figure 15b.

SM&B

THE STANDARD MODEL AND BEYOND

- ① RGEs (α_i ($i = 1, 2, 3$); m_j ($j = q, l, G, H$); $f(k^2)$).
 - GUT ($\alpha_{\text{GUT}} \approx 1/24$) & GAP ($10^{16} - 10^{18}$) GeV.
 - SUSY (to stabilize $m_p/m_F \approx 10^{-17}$).
 - RQST (to quantize Gravity).
- ② Gauge Principle (hidden and expanded dimensions).
 - How a Fundamental Force is generated: SU(3); SU(2); U(1) and Gravity.
- ③ The Physics of Imaginary Masses: SSB.
 - The Imaginary Mass in SU(2)×U(1) produces masses ($m_{u^*}, m_{d^*}, m_q, m_l$), including $m_0 = 0$.
 - The Imaginary Mass in SU(5)→SU(3)×SU(2)×U(1) or in any higher (not containing U(1)) Symmetry Group ⇒ SU(3)×SU(2)×U(1) produces Monopoles.
 - The Imaginary Mass in SU(3)_c generates Confinement.
- ④ Flavour Mixings & CP ≠, T ≠ (direct ≠, not via SSB).
 - No need for it but it is there.
- ⑤ Anomalies & Instantons.
 - Basic Features of all Non-Abelian Forces.

Note: q = quark and squark;	m_F = Fermi mass scale;
l = lepton and slepton;	m_P = Planck mass scale;
G = Gauge boson and Gangino;	k = quadrimomentum;
H = Higgs and Higgs;	C = Charge Conjugation;
RGEs = Renormalization Group Equations;	P = Parity;
GUT = Grand Unified Theory;	T = Time Reversal;
SUSY = Supersymmetry;	\Rightarrow = Breakdown of Symmetry Operations.
RQST = Relativistic Quantum String Theory;	
SSB = Spontaneous Symmetry Breaking.	

The five basic steps in our understanding of nature: ① The renormalization group equations (RGEs) imply that the gauge couplings (α_i) and the masses (m_j) all run with k^2 . It is this running which allows GUT, suggests SUSY and produces the need for a non point-like description (RQST) of physics processes, thus opening the way to quantize gravity. ② All forces originate in the same way: the gauge principle. ③ Imaginary masses play a central role in describing nature. ④ The mass-eigenstates are mixed when the Fermi forces come in. ⑤ The Abelian force QED has lost its role of being the guide for all fundamental forces. The non-Abelian gauge forces dominate and have features which are not present in QED.

Figure 16.

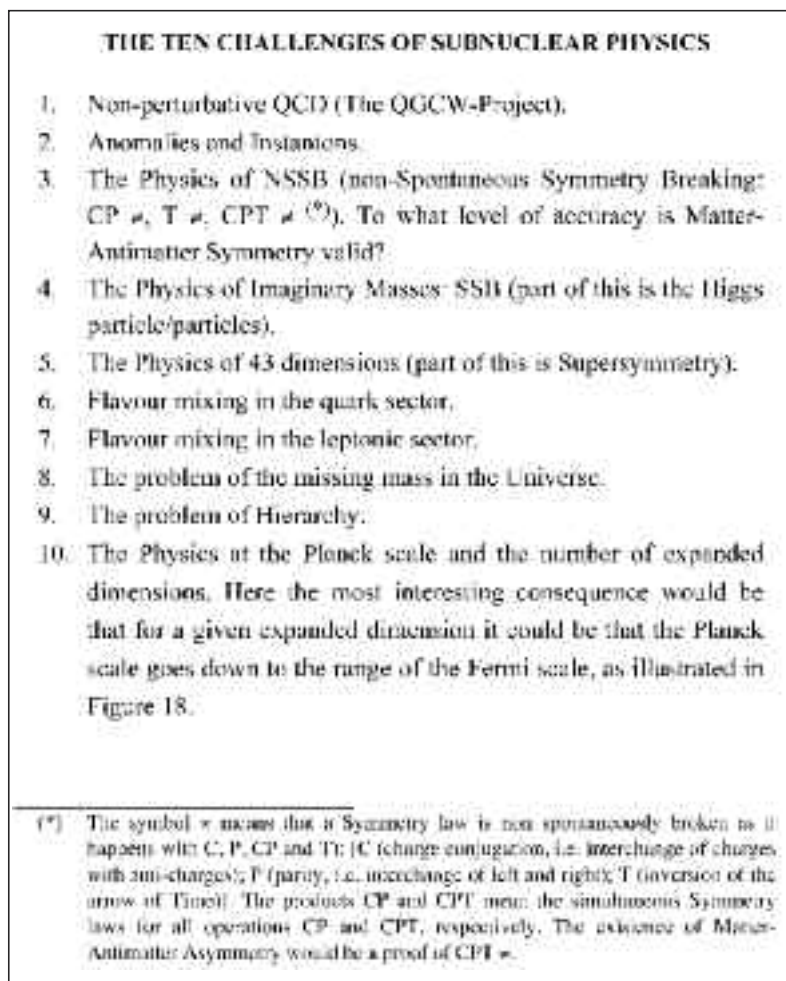


Figure 17.

4. Conclusion: The Scientific Legacy of the 20th Century

Here is the Legacy: *Our father is not chaos. We are the children of a formidable, Rigorous Logic which is valid from the smallest structures of the Subnuclear World to the borders of the Universe.*

The whole of our knowledge is proof of it, as shown in Figure 19. In fact, if we were the children of chaos, the contents of this Figure would not exist. If a fellow could deduce the content of Figure 19 from chaos, the Legacy quoted above would be in trouble. This fellow does not exist.

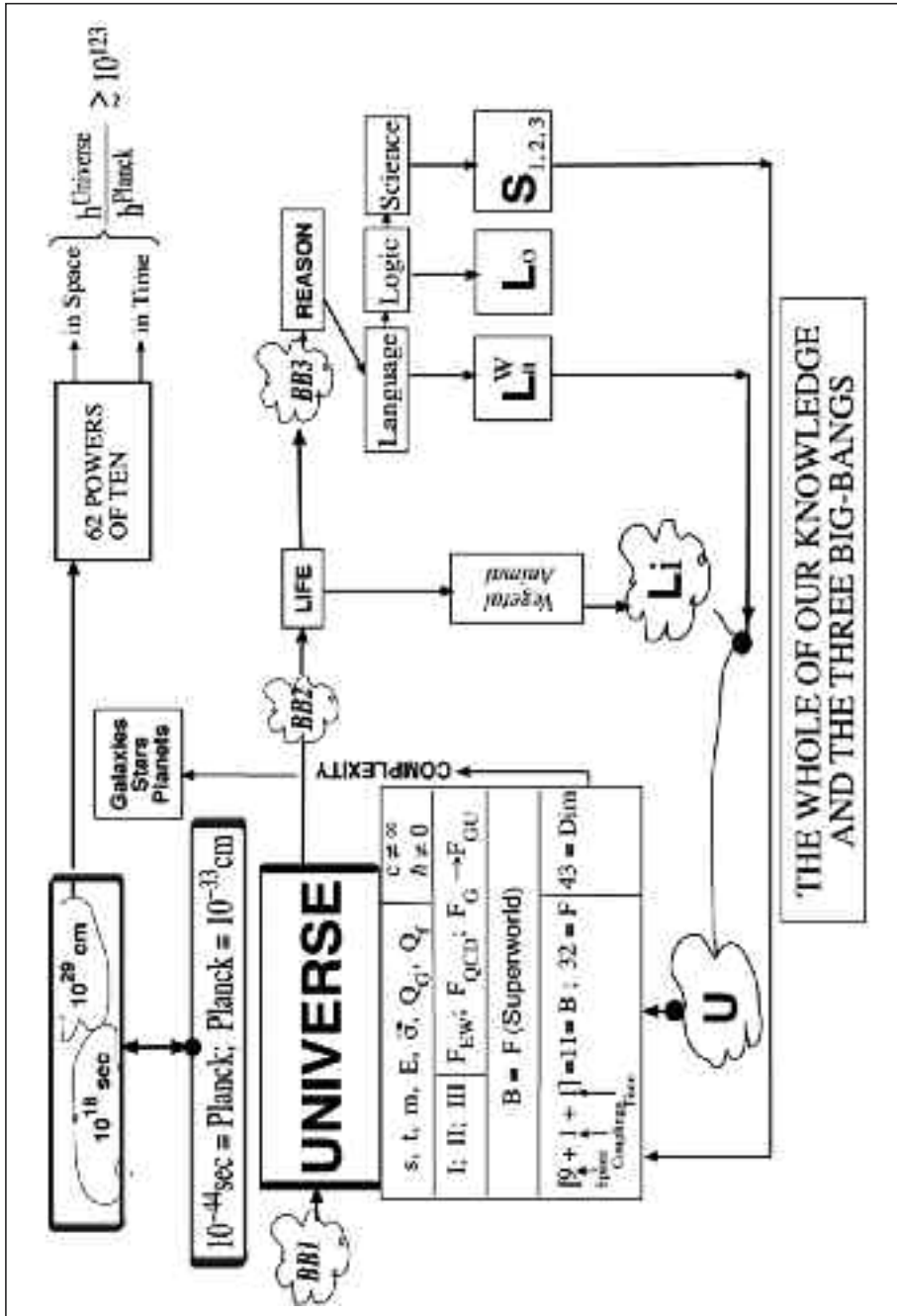


Figure 19.

APPENDIX 1

Atheism is an Act of Faith about Nothing

1.1. Reason according to Atheists

For Atheistic Culture, Reason is the outcome of the Biological Evolution of the Human Species. The Biological Evolution of the Human Species (BEHS), however, lies below the third level of scientific credibility (see Appendix 2). This can be clearly understood by comparison with the Cosmic Evolution.

BEHS lacks rigorous mathematical formulation and is not based on reproducible experiments at the first level. If BEHS were Science at the first level, then a BEHS equation would exist, leading to the outcome of Reason. And that is not all. There are innumerable forms of living matter. None of these, however, has been able to discover Science, or rigorous Logic, or Collective Memory. BEHS is unable to explain how it is that we are the only form of living matter that has the great privilege of being endowed with Reason.

1.2. Atheism is self-contradictory

Atheism is a contradictory logical construction. In fact, it denies the existence of the Transcendent.

Since the greatest conquests of Reason in the Immanent are Language, Logic and Science, Mathematics (rigorous theoretical Logic) should be able to demonstrate that God does not exist, and Science (rigorous experimental Logic) should be able to discover that God does not exist.

Mathematics has not demonstrated the Theorem of the Denial of God and Science has not discovered the scientific proof of the non-existence of God.

If everything finds expression within the Immanent alone, how is it possible that there is no Theorem of the Denial of God, nor the scientific discovery of the non-existence of God? Here is the contradictory nature of the logical construction of Atheism.

1.3. The Transcendent solves the contradiction of Atheism

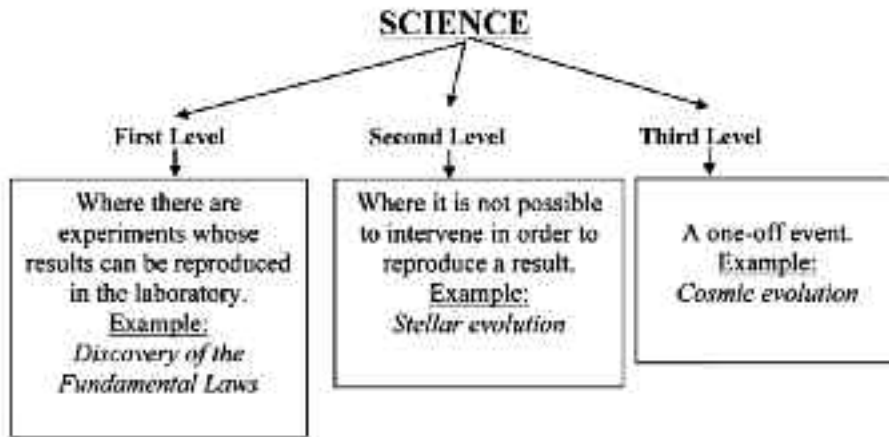
In the Logical Structure of the Believer, there exists the Transcendental Sphere, and Reason is a gift of God.

God has given us this unique privilege that has allowed us to make the Three Great Conquests. Logical Mathematics is not able to demonstrate the Theorem of the Existence of God in that, if it could, God would be Mathematics alone. God instead is everything. The same is true for Science. If Science were to manage to discover God, then God would have to be just

Science. But instead, God is everything. It is the task of philosophical thought (see Appendix 6.4) to demonstrate that God exists through the Transcendental Sphere of our existence and its connections with the Immanent Sphere of everyday life.

APPENDIX 2

A Note on the Three Levels of Science



In order to be 'scientific', an activity needs the existence of the first level: i.e., experiments with reproducible results in a laboratory. The results must be expressed in mathematical terms with the correspondent uncertainty quoted.

If the experiment is reproduced in another laboratory and gives results which are in contradiction with previous knowledge it is necessary to establish which one of the experiments is wrong.

In the given activity, it must be possible to put different experiments in a mathematical formalism which allows 'predictions' to be made (see Appendix 5.2). The best example of such an activity is the series of experiments in electricity, magnetisms and optics that after two centuries allowed Maxwell to find four equations from which all results could be derived. The four Maxwell equations gave rise to the most powerful understanding of the effects generated by the electromagnetic forces which allow *predictions* to be made with very high precision. This understanding is known as Quantum ElectroDynamics (QED).

Many activities can become 'scientific' if they follow the example of QED. Otherwise, the existence of the second and third level must be continued until the first level is discovered in the given activity.

When this happens to be the case all three levels must be formulated in a rigorous way, and there should be no contradiction among them. An example of the link between the three levels of Science: Cosmic Evolution formulated in a rigorously mathematical way, and based on the discoveries of the Fundamental Laws made at the first level.

No phenomena known in the Galilean sense (i.e., rigorously reproducible) exist that cannot be explained as a consequence of first level Science. This represents the greatest conquest of Reason in the Immanent.

This study, undertaken by Galilei just four centuries ago, leads us to conceive of the existence of a reality even more exciting than the one we are used to – a reality of extraordinary symmetry which has been called Superworld (see Appendix 3.4).

APPENDIX 3

Language (Permanent Collective Memory), Rigorous Logic and Science (From the Stones to the Superworld)

3.1. The greatest conquests of Reason are Language (with Permanent Collective Memory) Logic and Science

If Language were sufficient to discover Science, it would have been discovered at the dawn of civilisation. If rigorous Logic were sufficient to discover Science, it would have been discovered by the Greeks.

To discover Science, it is not sufficient to think and reflect (Language), or to resort to rigorous reasoning (Mathematical Logic). To discover Science (Logic of Nature), there is one single route: to be able to find rigorously formulated questions. This requires an act of humility: the recognition that the Author of the Logic of Nature is more intelligent than any of us – philosophers, thinkers, mathematicians, logisticians, scientists. It is necessary to surrender before the intellectual Majesty of He who made the world.

It was Galilei who understood this. It was he who said that the footprints of the Creator were to be found in the stones (just as in the Stars). Galilei brought the Logic of the Stars into common matter (stones, string, wood), through an act of Faith on the existence of a fundamental Logic which governs the real world (see Appendix 5.1).

In pre-Galilean thinking, *for Atheists and believers alike, matter could not be a depository of fundamental truth*. The Fathers of the Church were the first to say that Nature is a Book written by God. Galilei had the privilege of understanding that the characters of that Book had to be mathematical, and that it was not enough to reflect on the heavens and Stars.

All previous cultures attributed to the heavens properties that lay above those of the stones. Galilei brought the Logic of Nature into stones and common matter, saying that our intellect has a power below that of the Author of the Logic of Nature. And thus it is necessary to bow before His intellectual Majesty and ask humbly how He has made the world. In other words, what rigorous Logic – of all possible logics – did He follow to make the world as it appears to our eyes and our intellect. The significance of a rigorous and reproducible experiment is precisely what Galilei intended and experienced: to humbly ask a question to the Author of the Logic.

3.2. Ten thousand years compared with four centuries

This is how, in just four centuries, we have managed to decipher a good part of the Logic of Nature. And we have managed to understand just how right was Galilei's humility. In fact, from the dawn of civilisation right up to Galilei – in other words, for a good ten thousand years – all that man thought he had discovered about how the world was made, without ever carrying out an experiment, turned out to be wrong. Still today, Galilean teaching rules the logic of all the scientific laboratories in which the Fundamental Laws of Nature are studied.

Here is a last example of enormous interest today. No one can tell us whether the Superworld exists or not. And yet this theoretical reality is based on rigorous mathematical foundations. It is on these foundations that we believe we have understood so many properties of the world in which we live. But even so, the Galilean proof to be certain of the existence of the Superworld is lacking.

Logical rigour is not sufficient; we need Galilean proof. To know more about the Logic of Nature it is necessary to be able to formulate the right questions to the Author of the Logic who made the world. This is how, in just four centuries, we have reached the threshold of the Superworld.

3.3. From Galilei to the Superworld via Fundamental and Universal Laws

Galilei studied stones in order to discover the Logic of Nature. He could have discovered chaos instead. Had Galilei not existed, we would know nothing about the existence of the Fundamental Laws of Nature. So two questions arise:

- what did Galilei know about the fact that the Fundamental Laws of Nature had to exist?
- and on what foundations was he able to conceive that these Laws had to be Universal and Immutable?

Imagining the existence of Universal and Immutable Fundamental Laws does not involve acts of Reason and nothing else, but of Faith in the existence of a Logic of Nature which governs the world in all its structures.

Were it not for Galilean Science, we would not be able to say that Fundamental Laws of Nature, Universal and Immutable, exist; nor that these Laws lead to the unification of all the phenomena studied in the visible Universe, which appears to us with just four dimensions.

The Grand Unification brings with it the need for a Superworld, a scientific reality with forty-three dimensions: eleven of the ‘boson’ type and thirty-two of a ‘fermion’ nature.

3.4. Why we need the Superworld

Here are the problems that make the Superworld a necessity.

- 1) The two energy scales must be kept separate: 10^{19} GeV (Planck) and 10^2 GeV (Fermi).
- 2) The gravitational attraction of light must be prevented from being infinite. Otherwise we would see neither the light of the Stars nor the light of our Sun. The ‘gravitino’ (Supergravity) allows the gravitational attraction of light to be finite.
- 3) Gravitational attraction is powerful but it cannot be infinite. We would be stuck to the Sun. Space would not exist between Stars and Galaxies. Cosmic expansion would not exist. In order to have a finite gravitational attraction, theories are needed in which the Euclidean concept of point is abandoned. The point is replaced by a string. No more Pointlike Theories but Superstring Theories. These theories must be supersymmetric: the Supersymmetry Law ($F \equiv B$) must be valid. Otherwise ‘tachions’ would appear.
- 4) Aiming at the Unification of all fundamental phenomena – the synthesis of which is provided by three ‘gauge couplings’, $\alpha_1 \alpha_2 \alpha_3$, running with the energy – the Supersymmetry Law ($F \equiv B$) must necessarily be introduced.
- 5) Supersymmetry does not show up at our energy scale. Hence the problem arises to compute the energy above which the ($F \equiv B$) Law starts to act. Thanks to the EGM effect, this energy level is 700 times more accessible than thought so far.
- 6) An interesting detail: the theoretical model called no Scale-Supergravity is the Infrared solution of Superstring Theory. This model might allow us to understand the extremely small value of the Cosmological Constant.
- 7) Finally: why Three Columns and Three Forces? The answer to this question should come from the 43-dimensions of the Superspace.

3.5. Where the ashes of the Superworld could be

The ashes of the Superworld (the so-called neutralinos) could explain the compactness of our Galaxy.

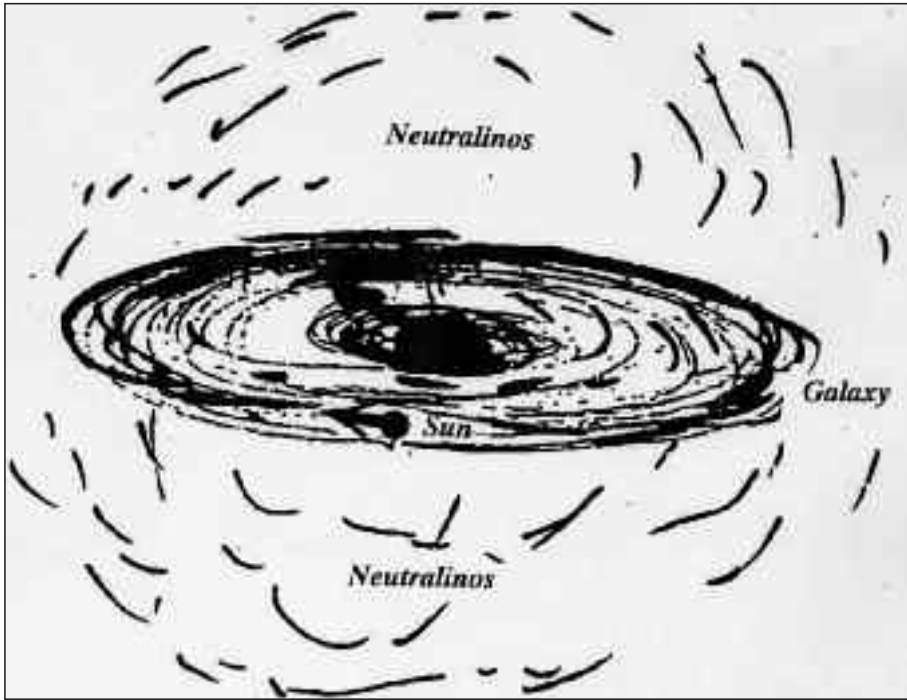


Figure 20.

Neutralinos cannot aggregate into Stars since, being neutral, they lose little energy. This would allow neutralinos to remain in a sphere concentric with our Galactic centre. Even though they aggregated into Stars, neutralinos could not emit light, like ordinary Stars do. Fire needs the plasma of protons and electrons. This is why super Stars cannot emit light.

3.6. Our World and the Planck World

It is interesting to compare the density of our body and the density of the Planck Universe. The scales of length, mass and time of the world we are familiar with, and the scales of the Planck world are shown in Figure 21.

OUR WORLD	THE PLANCK WORLD
Human Body Density 1 gr/cm^3	Planck Density $10^{37}\text{ Universes/cm}^3$
OUR SCALE of Length, Mass and Time length cm mass gr time sec	THE PLANCK SCALE length 1.6×10^{-33} cm mass 2.2×10^{-5} gr time 5.4×10^{-44} sec
Everyday Reality	The Reality we come from

Figure 21.

APPENDIX 4

The Values of Science and Faith are Closely Linked

We will now see that Science is a source of values, and that these values are in perfect harmony with the values of Faith, not in antithesis. Below is a short summary of the values that Science has in common with Faith. The description of each value follows.

- 1 *REVOLUTION*
- 2 *RACISM*
- 3 *UNIVERSALITY*
- 4 *ELEVATION OF THE INDIVIDUAL*
- 5 *INTELLECTUAL STIMULUS*
- 6 *HUMILITY*
- 7 *TRUTH*
- 8 *REFLECTION ON FACTS*
- 9 *GOODNESS AND TOLERANCE*
- 10 *FIGHT AGAINST PRECONCEPTIONS*
- 11 *GENEROSITY*
- 12 *FREEDOM OF THOUGHT*

4.1. *Revolution*

Let's begin with the concept of revolution. When a scientific discovery is made, the dominant Culture loves to point out that a real revolution has taken place.

Scientific revolutions have never produced deaths or injuries. The concept of 'revolution' derives from the discovery that it was the Earth and the other satellites of the Sun that move, going around in their orbits. It was the 'revolution of the orbits' that gave life to Galilean Science. The term 'revolution' intended to emphasise the impact of the 'revolution of the orbits' of the planets on the history of the world. With the passage of time, cultural mystification went to work to change the scientific term 'revolution of the orbits' into the meaning of 'socio-political revolution', like the October Revolution that led to the first example of a Republic with Atheism as State religion, causing many millions of victims.

Instead, following a scientific revolution, everyone is richer than before. It would be more correct to speak of construction, rather than revolution. In Sci-

ence, there is never denial of the past: it is improved on, taken on board and built on. It is as if, when climbing an immense mountain, what we took to be the summit opens up a panorama never before observed – and, as if this were not enough, with it comes the discovery that there is another, even higher, peak.

The term scientific *revolution* does not in any way justify social revolution. But this is what the dominant Atheistic Culture indeed did, in order to persuade that, after all, scientific rigour had necessarily to go down the road of *revolution*, understood in the commonly accepted sense of revolt, with attendant massacres and horrors of every type.

4.2. Racism

A scientist cannot say: ‘I am unable to believe in this new scientific discovery because it was made by a man whose skin is a different colour from mine’. Science is an intellectual activity that rejects racism outright.

4.3. Universality

Man has always been in search of universal values. Science shows that Universal Laws exist. The Weak Forces that produce measurable phenomena in our laboratories are the same as those that make the Sun work. The light produced by a match is analogous to that produced by the Stars. Gravitational Force, which makes a stone fall downwards and holds us to the Earth is the same Force that oversees the formation of our Solar System and of the Galaxies.

4.4. Elevation of the individual

Science exalts the individual and his work. The value of a scientist is not established by the power of an army tank, but by his intellect and research efforts.

And here the entire sum of contributions must be recognised. Albert Einstein is inconceivable without Max Planck, James Maxwell, Isaac Newton and Galileo Galilei. All scientists, giants of Science: all believers.

4.5. Intellectual stimulus

Science spurs man on to reach out for further conquests. There is no rest in our endeavour to extend and improve our knowledge. Instead, an ideology is put forward as if it were the final goal of an intellectual conquest. And this holds man back, century after century, on frontiers created from abstract speculations, which in no time at all become dogma.

Science accepts the dogma of the Transcendent. But it rejects the dogma of the Immanent.

4.6. Humility

The scientist in his daily work faces problems he is unable to resolve. Galilei took more than a decade to understand friction and thereby arrive at the formulation of the first law of motion. Einstein devoted eleven years, from 1905 to 1916, to get to the bottom of the significance of Galilei's experiments on the fall of material bodies. Eleven years to succeed in writing one equation. Science is made up of unresolved problems. Something happens, and we move on to the next thing. And there our difficulties begin again. Einstein worked for the last thirty years of his life in the attempt to unify all the Forces of Nature. It was his great, *unfinished* opus. How can a man who is unable to reply to a question be arrogant? Science, as we have said before, is made up of unresolved questions. This is why it is based on a pillar of intellectual humility. Arrogance is born of ignorance.

4.7. Truth

Should a scientist tell a lie, he would be excluded from the scientific context. For Science, something that is true has to be reproducible. The scientist, when he comes to understand something or make a discovery, has to explain in full detail how he has arrived at that result. Whoever, no matter the colour of his skin, has to be able to reproduce that scientific truth wherever, and at any given moment. Mystification and falsehood lie outside scientific activity.

4.8. Reflection on facts

Science teaches us to reflect, not to rush to conclusions without checking every consequence of a discovery in the known sectors of the fundamental structures of Creation. Science trains us for objective, not emotive, judgement. It relies on facts, experimental proof that is reproducible, the baptism of Galilean scientific legitimacy. It does not rely on words and abstract formulae. Nor does it make sense to say that a theory is mathematically beautiful or ugly. It can be only true or false, although it also happens, almost always, that when a piece of research reaches its conclusion, when everything has finally been understood in a specific field, then the mathematical formulation turns out to be more elegant than anticipated.

4.9. Goodness and tolerance

Science teaches intellectual goodness and tolerance. Extremes have to be understood, not defeated. Things that appear to be poles apart can both turn out to be necessary for a description of the fundamental phenomena of Nature. Just one example should suffice: the wave and particle property. Light, for a long time, was considered to be a particle phenomenon. Then wave-

like. And the two descriptions seemed to be mutually exclusive. Instead, light is at one and the same time both wave and particle. Many centuries have been necessary to come to this understanding. The wave-particle *duality* is valid not only for light, but for all particles. This duality is one of the most significant conquests in the history of scientific thought.

4.10. Fight against preconceptions

Science fights an unceasing battle against preconceptions: even if centuries are needed to dismantle them. The great difference between Classical Physics and Modern Physics lies in the fact that a tiny quantity (the so-called *Planck's Constant*) was considered to be exactly zero. Another enormous quantity (the speed of light) was considered infinite. Three hundred years to break down two preconceptions.

4.11. Generosity

Science also has important facets of generosity. Explaining to others the results of a discovery is something that enriches both scientist and listener. Science teaches that there exists an absolutely perfect form of generosity and love for our neighbour. He who gives up a piece of bread does a good deed, but clearly suffers if he has little bread. He who gives away what he knows, loses nothing, even if he ends up giving away everything he has.

4.12. Freedom of thought

Freedom of thought is of vital importance for Science. This includes respect for that form of living matter known as man, and therefore respect for his dignity. Of all the forms of living matter, we in fact are the only one which has been granted the privilege of understanding the Logic He followed in creating the reality in which we live and of which we are made. This unique privilege is the source of the highest dignity to which one can aspire: that of being made in the image and likeness of the Creator of all things visible and invisible. To read the Book of Nature, written by the Creator, one needs to be free of any prejudice, the only guide being the replies given by He who has made the world when we put forward a question. The intellectual freedom to put a question to He who has made the world has to be absolute.

APPENDIX 5

Chaos or Logic?

5.1. *If there is Chaos there are no Fundamental Laws. If there is a Logic there must be the Author*

Science aims at understanding what God has written, using the rigour of Mathematics. Galilei said and thought that the Fundamental Laws of Nature are in fact expressed as precise mathematical equations. The father of Science did not know that his studies of oscillating pendulums or stones rolling down an inclined plane would have allowed him to deduce rigorous laws. Chaos, randomness, whim might just as possibly have appeared instead: one day like this, a year later quite different. One law for Pisa, another for the Moon.

Galilei instead was thinking in terms of fundamental and universal laws, expressible in rigorously mathematical form. Together, these laws were to represent, and *de facto* do represent, the Logic of Nature.

‘In that stone there is the hand of the Lord. By studying *common objects* I will discover the Laws of He who has made the world’. This was the Faith that inspired Galilei to challenge the dominant Culture of his time. He simply wanted to read the Book of Nature, written by the Creator in mathematical characters.

The Book of Nature reveals to us how the world has been made: the work of Creation. This opus could have been written in no other way but rigorously, in mathematical characters. It is the scientist, in the first person, who has to strive in order for everyone to know how to read that astonishing and fascinating Book.

In it is written how the world is made. Since it is dealing with a construction, its language has to be rigorous. Knowing how to read it means making available for the benefit of man the laws that rule the Cosmos, in communion, not in antithesis, with the word of God, that is, the Bible. The Bible is written in a simple way, so that everyone can understand it; its purpose is not to explain how the Immanent part of our existence is made. Instead, it has the goal of tracing out for man the path that leads to the Lord. Science gives us the certainty of not being the children of Chaos, but of a rigorous Logic. Who is the Author of this Logic? Atheism replies: no one. This is why Science, born in the Immanent, brings man towards the Transcendent, because it is absurd that such Rigorous Logic does not have an Author.

5.2. *If there is Chaos there are no predictions*

Let us see how predictions at the fundamental level of scientific knowledge can exist. The experimental evidences for the existence of predictions are the very many results of scientifically reproducible experiments.

For example the measurement of the anomalous magnetic moment, in symbols $(g-2)_e$, of the electron (e):

$$(g-2)_e$$

which is theoretically computed at an extraordinary level of precision (few parts in ten billion parts) and is experimentally verified to be correct.

Could the

$$(g-2)_e$$

be predicted before the discovery of the Maxwell equations and the existence of Quantum ElectroDynamics (QED)?

Predictions at the fundamental level of scientific knowledge depend on UEEC events (discussed in the next Chapter 5.3).

For example: it is the discovery of the laws governing electric, magnetic and optical phenomena (all totally unpredicted) which produced the mathematical structure called QED.

Mathematical structure was not invented before the innumerable series of UEEC events in electricity, magnetism and optics which allowed Maxwell to express 200 years of experimental discoveries in a set of 4 equations.

Mathematical formalism comes after a totally unexpected discovery: an UEEC event which no one was able to predict.

In the whole of our knowledge predictions exist only in Science.

These predictions are the analytic continuation of what is already known. The greatest steps in the progress of Science came and will come from totally unpredicted discoveries.

This is the reason why we need to perform experiments, as Galileo Galilei realized, 400 years ago.

Today we have all mathematics needed to describe the Superworld, but in order to know if the Superworld exists we need the experimentally reproducible proof of its existence (as discussed in Appendix 3).

5.3. If there is Chaos there are no UEEC events. UEEC are the proof that the Author of the Logic is smarter than us all, no one excluded

5.3.1. Unexpected Discoveries in Physics

Let me show a synthesis of achievements in Physics from Galilei to the first half of the 20th Century (Figures 1 and 2, pp. 94-95).

I have included the invention of electronic computers by Von Neumann (XXIX), which no one could have imagined at the beginning of the 20th Century. Point no. XXX refers to the impressive list of Fermi discoveries:

once again, all totally unexpected. The UEECs of the second half of the 20th Century (Figure 3, p. 96) are grouped into 3 classes:

- one is the ‘Subnuclear World’
- the second is the ‘Standard Model and Beyond’
- the third is the ‘Superworld’.

The existence of the Subnuclear World and the Standard Model are strictly correlated. The third is the frontier of our knowledge which exists as a fascinating mathematical structure, but lacks Galilean experimental proof (as discussed in Appendix 3).

The greatest synthesis of all times in the study of fundamental phenomena (Figures 13 and 14, pp. 103–105) has been reached through a series of totally unexpected discoveries reported in Figures 16 (p. 107) and 22 (p. 363).

5.3.2. The Standard Model and Beyond

The superb synthesis called the ‘Standard Model’ is a part of a more general structure, where many problems are open. We call this structure ‘The Standard Model and Beyond’, ‘SM&B’ (Figure 16, p. 107).

This Structure brings to the unification of all Fundamental Forces of Nature, suggests the existence of the Superworld and produces the need for a non-point-like description of Physics processes (the so-called Relativistic Quantum String Theory: RQST), thus paving the way to quantizing gravity.

5.3.3. Conclusions about UEEC from Galilei to Subnuclear Physics and other fields

In the field of Subnuclear Physics, totally unexpected discoveries date back to the beginning of Galilean Science.

Question. *What about other fields?* One which is very intensive in number of discoveries is the field of condensed matter.

Let me quote Tony Leggett (University of Illinois, Urbana – Champaign, USA), Nobel Prize 2003 for ‘Superfluidity’: ‘It is relatively rare in Condensed-Matter Physics to predict discoveries; it is a field where you fall over them by accident’.

APPENDIX 6

If Our Culture were Modern, the Cultural Mistifications which are in the 'Present Convictions of a Modern Culture' would not Exist

6.1. If we were to live in the Era of Science everybody would know that Science and Faith share the same values

If we lived in the era of Science, the values of Science would form an integral part of the so-called Modern Culture. In fact, they are truths that render Science an intellectual activity that is in perfect communion with religious thought. We are dealing with two essential components that make up our existence: one that operates within the Immanent, Science; the other that operates within the Transcendent, Faith.

And this is the conclusion one comes to. Science, by studying the Immanent in the most rigorous way that human intellect has ever been able to conceive, discovers a series of truths, whose values (see Appendix 4) are in perfect harmony with those that the same form of living matter, called *man*, learns from Revealed Truth.

Four centuries after the time of Galilei, that which the father of Science was able to see with a pure act of Faith and Love towards Creation becomes visible in dazzling clarity: Nature and the Bible are both works by the same Author.

The Bible – said Galilei – is the word of God. Nature instead is His writing. If we lived in the era of Science, these truths would be the cultural heritage of everyone.

6.2. A few examples of cultural mystifications in 'Scientific' popularisation

Scientific Culture has the duty to correct the cultural mystifications of the popularisation of science, mystifications that might at first sight seem mistakes committed in good faith. But the fact that they are all bound to a common cultural substrate confirms that they are not. In fact, the mystification that Faith and Science are in antithesis is not the only instance where falsehood is elevated to truth by popularisation of science. There are many more. Here are a few examples.

Popularisation of science has:

- confused Science with Technology.
- never explained that the three great conquests of Reason are: Language, Logic and Science (Appendix 3).
- always kept silent regarding the Galilean distinction of the three levels of scientific credibility (Appendix 2).
- attributed to Science the responsibilities of the Planetary Emergencies; responsibilities that belong instead to political violence (planet packed

with chemical, bacteriological and nuclear bombs) and economic violence (irresponsible industrialisation and related effects).

- elected itself spokesman of ideas (for example: scientific materialism) that are in total contradiction with the conquests of scientific thought.
- endorsed as frontiers of true and great Science research activities that still lie below the third level of scientific credibility (for example: BEHS, biological evolution of the human species).

Our epoch will go down in History as that in which cultural mystification has raged: falsehood becomes truth. The main author of this mystification has been the dominant Atheistic Culture.

In this way, Science and Technology have been deliberately confused. And the blame continues to be laid at the feet of Science, a blame that instead belongs to political violence. Violence which, in the 20th Century, had examples of terrifying power in Hitler and Stalin; they both exploited the use of Science (Technology) for political ends, not for progress or civilisation.

6.3. If everything is Science, nothing is Science. It is necessary to distinguish Science from the other conquests of Reason. There is only one Science

‘Scientific Culture’ is the only form of defence against cultural pollution, maintained Dirac, Kapitza and Fermi. If everything is Science then nothing is Science. And it is impossible to explain that scientific Marxism is the exact opposite of Science. It is thus necessary to distinguish Science from the other conquests of Reason – i.e., from Mathematical Logic and Language.

The umbrella of Language covers Poetry, Art, Philosophy and all intellectual activities that are not concerned with reading the Book of Nature in order to decipher the Logic followed by He who has made the world. Using Language, in all its forms, everything can be said and its contrary. Language – as Borges says – has the supreme aspiration of ‘magnificent’ structures such as a Poem can have, leaving aside Logic and Science, which is the Logic of the Nature.

Scientific knowledge is engaged full time in studying – in a Galilean reproducible way – this Logic. The key to distinguishing this activity from all others lies in intellectual humility, without which scientific knowledge would never have been born nor able to grow. This intellectual humility, which is vital for scientific knowledge, is not always present – in fact, often quite the reverse – in intellectual activities that contribute to the growth of non-scientific knowledge. This is why there is only one Science, while there are many forms of Art, Literature and Philosophy and other intellectual activities, often in contradiction one with another.

6.4. *Humanistic Culture is not in contrast with Scientific Culture. The role of philosophical thought*

This has been the case in the past and will continue to be so in the future. Even so, it is philosophical thought that produces fundamental contributions in the study of the Transcendental Sphere of our existence.

The contradiction intrinsic in Language's very structure is surmounted when Philosophy comes into play: its roots allow an understanding of how and why this contradiction does not have to extend beyond the conquests of Language.

In other words, the fact that there are various forms of Poetry, Art, Music cannot be taken as a basis on which to build a *Humanistic Culture* in contrast with *Scientific Culture*. The contradiction lies in the Creativity of Language itself, from which arise various expressions of our way of hearing and seeing the world. It is right that it is so. It is required by Language's very structure. It is here that the links with the Transcendental Sphere of our existence come into being, links that extend to Logic and Science through the creative processes of these great conquests of Reason in the Immanent. Creativity in Language finds its maximum structure in philosophical thought, without which it would not be possible to reflect on the Transcendental Sphere of our life. It is at this frontier that Philosophy expresses the highest creative power.

Creativity in Science has to coincide with the Logic chosen by He who has made the world to create the reality we are made of and in which we live. We scientists are not able to invent the existence of the Third Lepton (see Chapter 2). We can imagine its existence on the basis of experimental results, which can suggest new avenues for us to follow.

But whether the third lepton exists is known to the Creator, before any scientist in the world. It is He who has decided to include this 'third column' in the structure of Creation. We have been granted the privilege of discovering that it does indeed exist. The same is true for the existence of Anti-matter and all other discoveries in which I have been directly involved, as reported in Chapter 2.

6.5. *Creativity in Mathematics*

With Mathematical Logic, the significance of Creativity is different. It is a legitimate act of the intellect to invent a new mathematical structure: with its rules and theorems. This structure does not necessarily have its correspondence in the Logic of Creation.

In order for this mathematical-logical structure to exist, the only condition is the principle of non-contradiction. But the principle of non-contradiction arises in philosophical thought, an integral part of Language. Logic

formulates this principle rigorously, and uses it to underpin any of its structures. A structure – completely invented by the intellect – must not lead to a theorem and the negation of the theorem itself.

Having said this, the problem of the role of Mathematics in the Logic of the Creation remains open: this topic has impassioned the very best mathematicians of all time. There is no doubt that a formidable logical-mathematical structure can exist (and therefore be non-contradictory), without there being any correspondence with the reality of the world in which we live and of which we are made.

This in no way diminishes the fascination of the Creativity in the two conquests of Reason (Language and Logic), which, since they are distinct from Science, do not fall under Galilean-type experimental confirmation.

However, it is of fundamental importance to distinguish Science from the other two conquests of the Reason of the Immanent, in that, if everything is Science, then nothing is Science, with all the devastating cultural consequences, some of which are referred to in this Section.

6.6. Cultural pollution

Kapitza said: ‘Cultural pollution is the most difficult Planetary Emergency to overcome’. Here is an example. In the USSR, very few knew of the ecological disasters caused by the triumphs of the ‘five-year plans’ made known everywhere through propaganda campaigns, even in the western world, where they were taken as models of unprecedented development. In Italy, Communist Party members made great reference to them. No one, however, spoke of the ecological disasters of *Semipalatinsk* (100 times worse than Chernobyl), the *Aral Sea* (50% of its waters destroyed), the *City of Sulphur* (an area as large as half of Piedmont, contaminated to the point where the population had to go around wearing gas masks). These were the times of the cold war and no one dared to hope for the collapse of the USSR. But even so, the hero of Science, Pëtr Kapitza, considered it necessary to start immediately to fight cultural pollution in countries that were free; in those dominated by the USSR it was unthinkable. Dirac said: ‘It is easy to declare ourselves as free men where there is democracy and freedom. Try to do this where political violence rages. Kapitza suffered the consequences during years and years of his life’.

Cultural pollution has its roots in political and economic violence, which, by dominating the media (TV, radio, press and other channels), has enabled so many flagrant cultural mystifications to become ‘truth’.

A terribly effective weapon of cultural pollution is pseudo-scientific confusion, an essential component of popularisation. To cite meaningless data as if they were Galilean proofs of scientific truth; to introduce apparently valid ar-

guments with bibliographic references that add nothing to the inexistent proof of the point in question: this is the technique of cultural pollution that destroys valuable energies from the struggle for the triumph of Scientific Culture.

6.7. An example of cultural confusion: Science, Art and Mysticism

According to a number of scholars, the pillars supporting our existence are: 'Science' (rational approach), 'Art' (aesthetic approach) and 'Mysticism' (religious approach). These theories have nothing new to say about the conquests of Reason. Rather, they go backwards in time because they ignore Galilean teaching. In fact, they confuse the Transcendental Sphere of our existence (to which Mysticism belongs) with the Immanent Sphere (to which Science belongs). Furthermore, they include in the so-called 'rational approach' both Science and Mathematics, confusing Science with Logic. Galilei teaches that, to discover Science, the rigour of Mathematical Logic (thus, the rational approach) is not sufficient.

If it were so, the Logic of Creation would have been discovered by the Greeks, two thousand years before Galilei. If mathematical rigour sufficed, we could say that the Superworld exists. The Galilean thesis is based on 'Language', 'Logic' and 'Science' and it could not be more rigorous in distinguishing the three conquests of Reason. Art in fact belongs to Language.

APPENDIX 7

A Great Alliance is Needed Between Science and Faith

In the 1980s this alliance strove to make a real contribution to overcoming the risk of a Nuclear Holocaust. Then, with the fall of the Berlin Wall came the need to avoid the danger of an Environmental Holocaust created by the political and economic violence that triggered the undeclared War between the planet's North (the rich) and South (the poor). Once again, Scientific Culture in communion with Faith acted to avoid the latent danger of an Environmental Holocaust, by implementing pilot projects related to the Planetary Emergencies, thanks to volunteer work carried out by its scientific community.

We have discussed how the dominant Atheistic Culture, using as its weapon the public dissemination of what is passed off as Science, has instead wanted everyone to believe that Science and Faith are enemies. It has always confused Science with Technology, has never explained that the three towering conquests of Reason are: Language, Logic and Science, never mentioned the Galilean distinction between the three levels of scientific credibility, and has laid at Science's feet the responsibility for the Planetary

Emergencies – responsibility that instead belongs to political violence (planet packed with chemical, bacteriological and nuclear bombs) and economic intemperance (unaccountable industrialisation). Atheistic Culture too has acted as a spokesperson of ideas, such as scientific materialism, that are in utter contradiction with the conquests of scientific thought, and has endorsed as frontiers of real and true Science, research activities that still lie below the third level of scientific credibility (for example: biological evolution of the human species: BEHS).

Had Atheistic Culture itself discovered Science, then the *Great Alliance* could never have been conceived. This Alliance represents the cultural guide for the third millennium. The birth of a Scientific Culture in communion, not in antithesis, with Faith has enabled the danger of a Nuclear Holocaust to be overthrown (Erice Statement), and allowed the creation of scientific and technological foundations from which to confront issues of the Environmental Holocaust (pilot projects for the Planetary Emergencies).

As said before, the 20th Century will take its place in History for having seen the fall of the Berlin Wall and the start of an undeclared War between North (the rich) and South (the poor). The third millennium needs the Great Alliance between the two most important conquests of Reason, which are Science, in the Immanent of our existence, and the God-given gift connected with Reason in the Transcendent of our being, Faith. We would do well to recall that St. Paul and all our theological tradition define Faith as a gift from God. A gift linked to Reason, as described by St. Thomas Aquinas: ‘Naturalis ratio per creaturas in Dei cognitionem ascendit, fidei vero cognitio a Deo in nos e converso divina revelatione descendit’^(*) (ScG IV 1, 3349). While emphasising the rational aspect of Faith, the entire Christian biblical tradition attributes it to the inner touch by the Spirit of God (*instinctus Dei invitantis*: St. Thomas Aquinas) that awakens the dynamism of free will. Faith is thus considered by Christian theology as a gift from God within man’s Reason, which under the impulse of this same free will, and aided by the Holy Spirit, accepts the gift.

We are the only form of living matter that has been granted the privilege of the gift of Reason and free will. Let us seek to use it well. The third millennium must open up man’s heart to hope through a Scientific Culture in synergy with Faith, not in antithesis. This is why – Benedict XVI teaches – Science must do everything in its power to ensure the triumph of the values of Galilean Scientific Culture.

^(*) ‘Natural reason ascends to a knowledge of God through creatures and, conversely, the knowledge of faith descends from God to us by divine revelation’.

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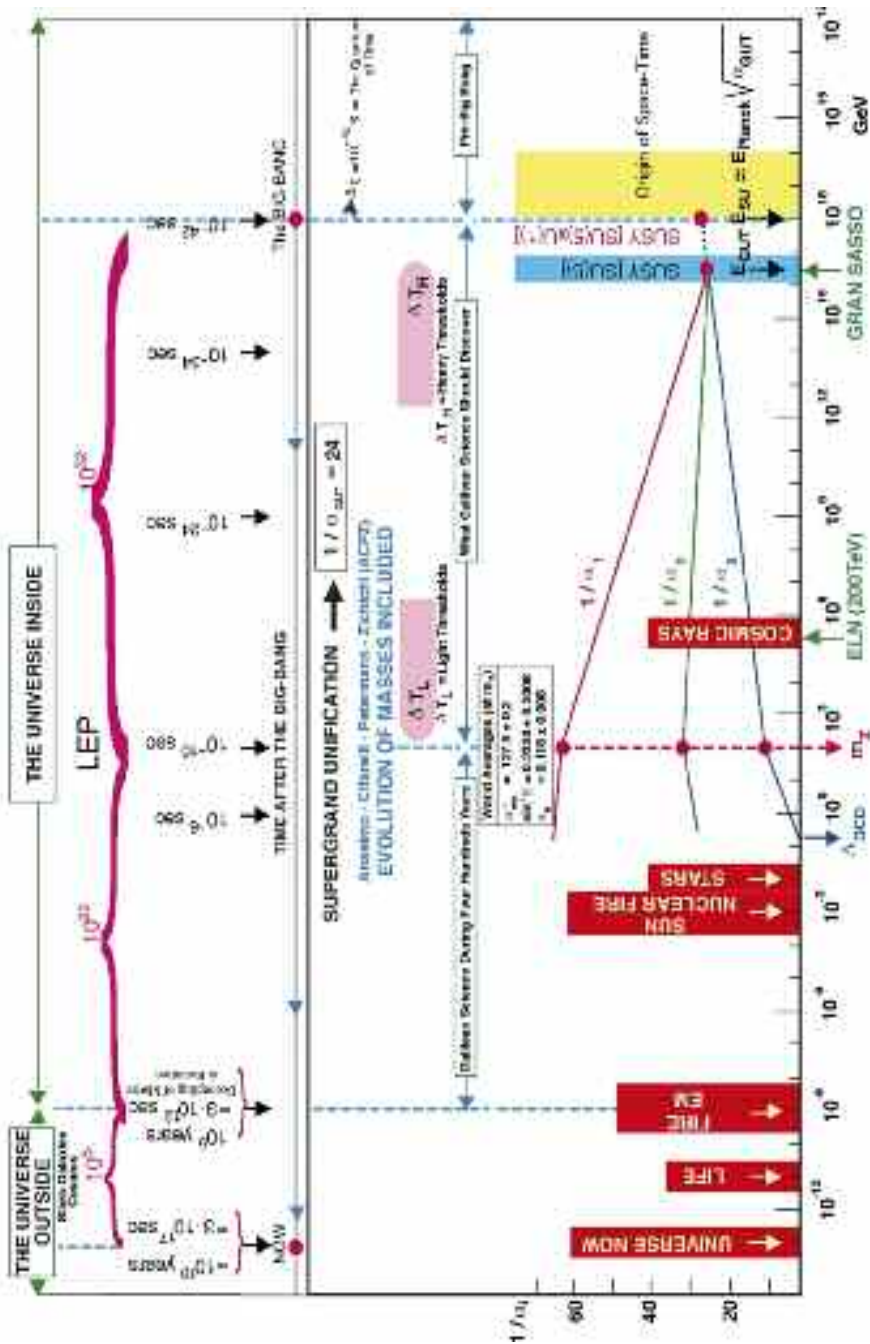


Figure 9.

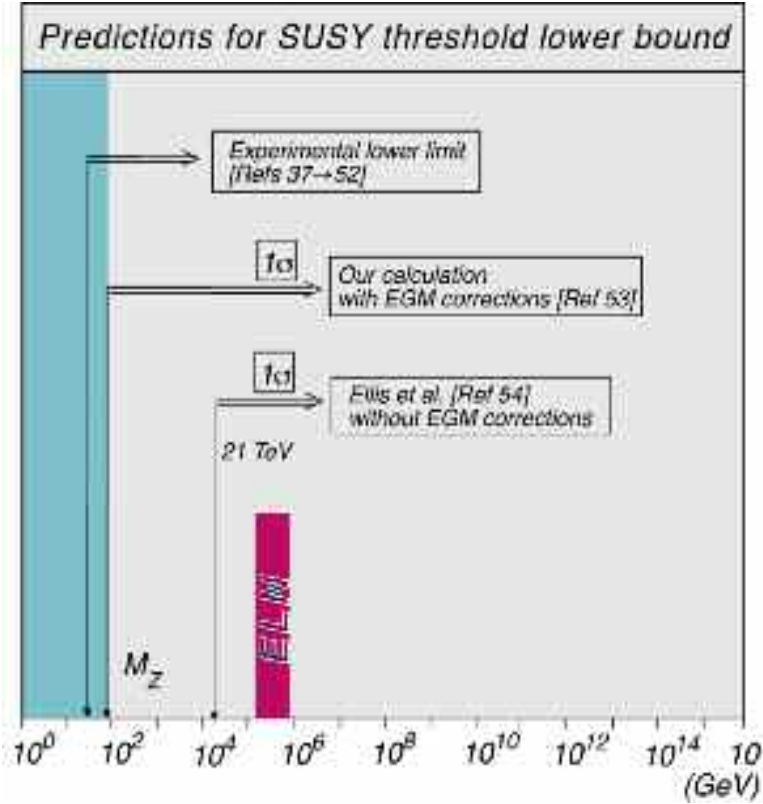


Figure 10.

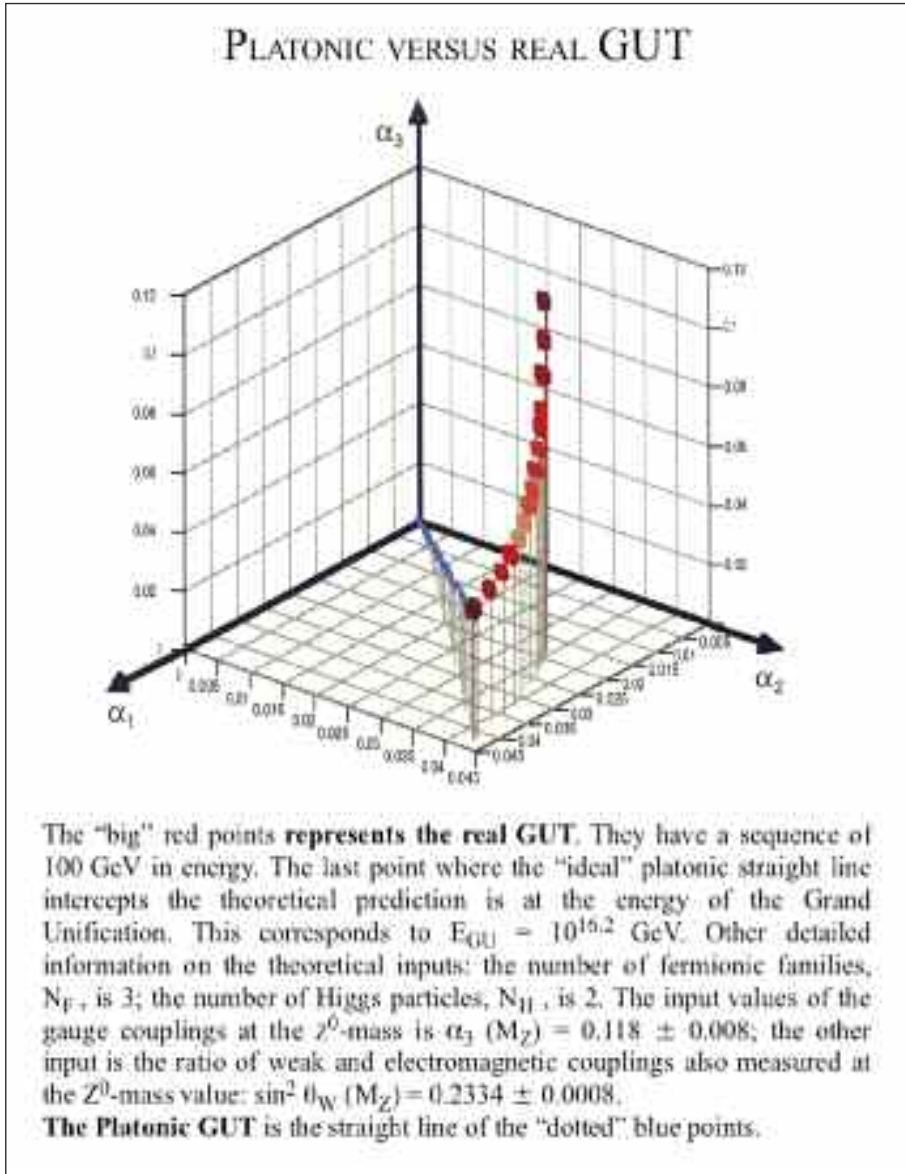


Figure 12.

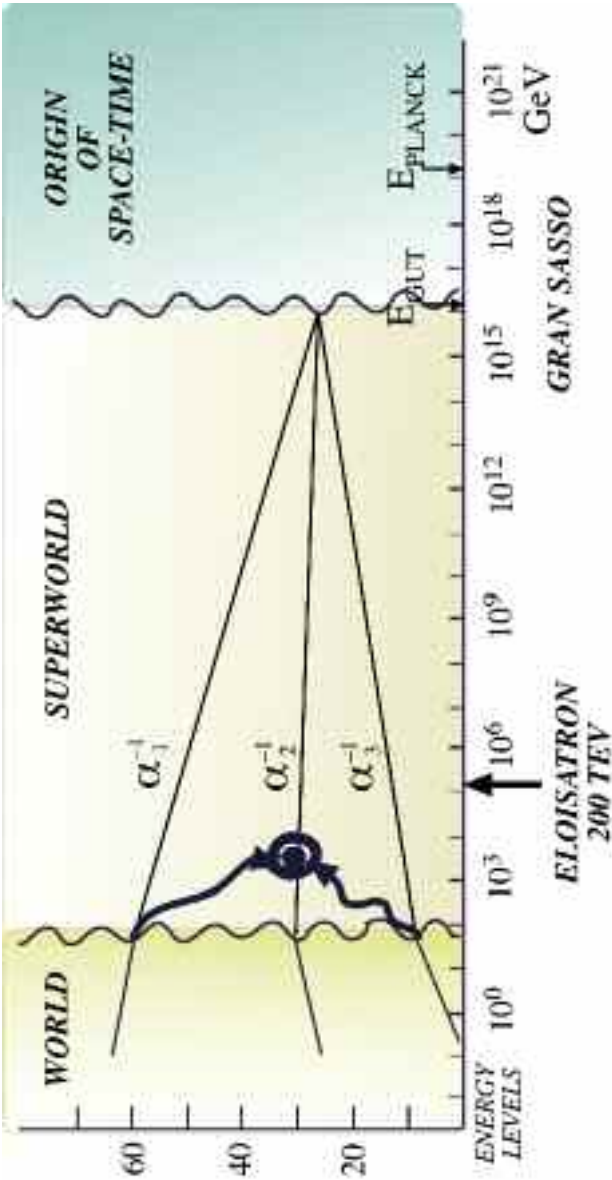


Figure 18.

