

International Symposium

60 YEARS OF

SUBNUCLEAR PHYSICS

IN BOLOGNA

FERRETTI, PUPPI AND THE DISCOVERY WHICH OPENED UP NEW HORIZONS IN SUBNUCLEAR PHYSICS

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Accademia delle Scienze dell'Istituto di Bologna – Sala Ulisse

Via Zamboni 31, Bologna, Italy

7 November 2018 at 09:30

Bruno FERRETTI \Rightarrow (Space-Time) \Rightarrow QED
(J.A. Wheeler)

Giampietro PUPPI \Rightarrow Triangle \Rightarrow QFD
Another Fundamental Force
(E. Fermi)

Today \Rightarrow Gravitational Waves ($7 = 6 + 1$)
As celebrated in this Higgs boson
Symposium promoted \rightarrow The greatest discovery of the XX
by Walter TEGA Century: Subnuclear Physics.

BRUNO FERRETTI interest was
on the problem of how
a **Fundamental Force of Nature**
(QED)
“comes into being”
from Space-Time.
This problem, after many decades,
is still
NOT SOLVED

Let me quote
JOHN A. WHEELER
(1977) [1]:

[1] *Frontiers of Time*

J.A. Wheeler, North-Holland, Amsterdam (1979), and private discussions.

On page 11 he writes :

*“It is preposterous to think
of the laws of physics as installed
by a Swiss watchmaker to endure
from everlasting to everlasting....
The laws must have come into being”.*

The mechanism of how
“The laws must have come into being”
should indeed be studied.

It was a problem in the discussions with Patrick Blackett and his friend Bertrand Russell [2], in the fifties.

After many decades it has been abandoned, since no one has been able to contribute towards a description of how the fundamental forces
“*come into being*”.

- [2] A Lesson for the Future of Our Science. My Testimony on Lord Patrick M.S. Blackett
A. Zichichi (World Scientific, 2016).

On page 11 Wheeler continues:

“Therefore they could not have been always a hundred percent accurate. That means that they are derivative, not primary”.

And on page 44:

“Of all strange features of the Universe, none are stranger than these: time is transcended, laws are mutable, and observer-participancy matters” [1].

[1] *Frontiers of Time*

J.A. Wheeler, North-Holland, Amsterdam (1979), and private discussions.

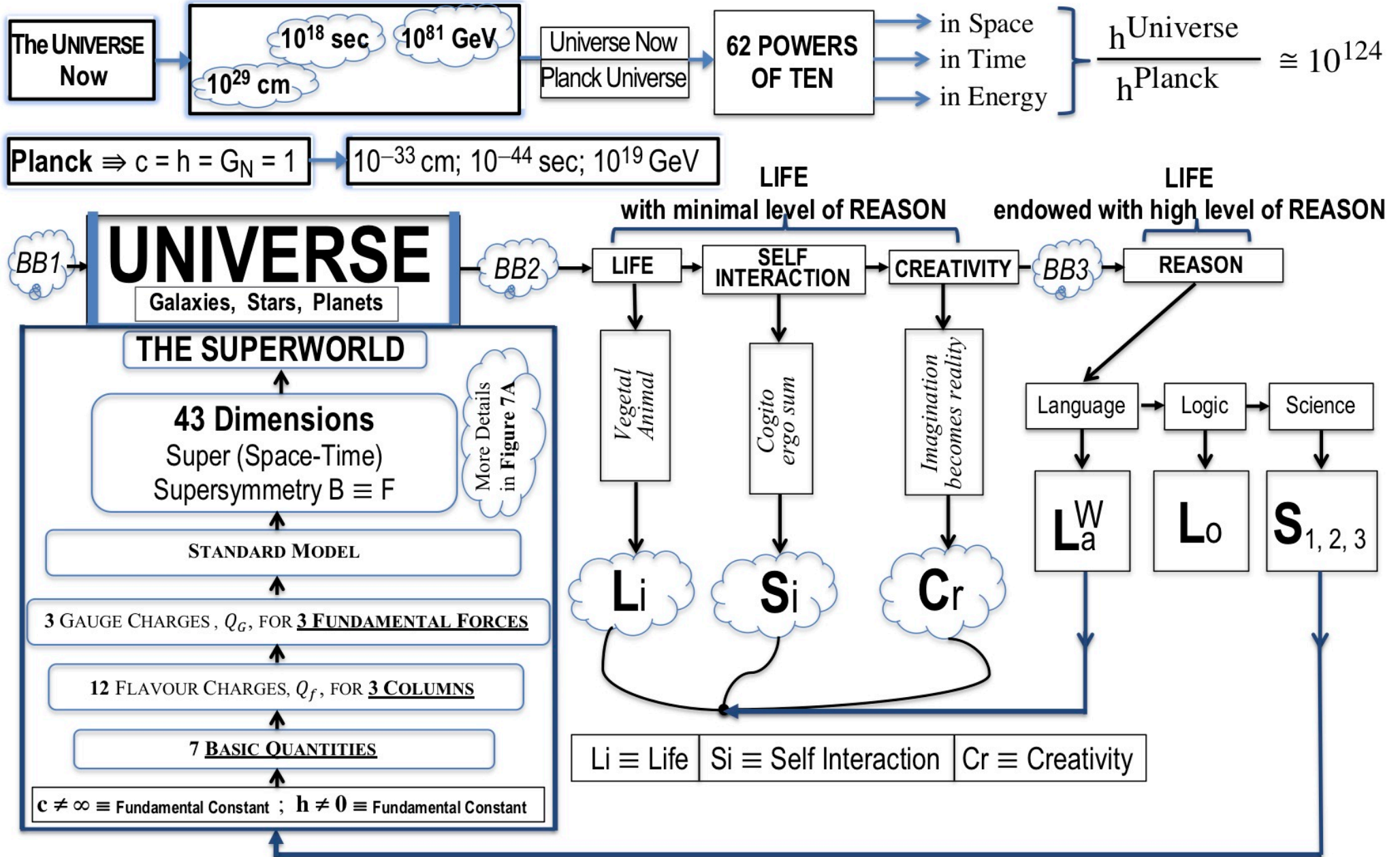
Conclusion:

The problem is now
much more difficult:

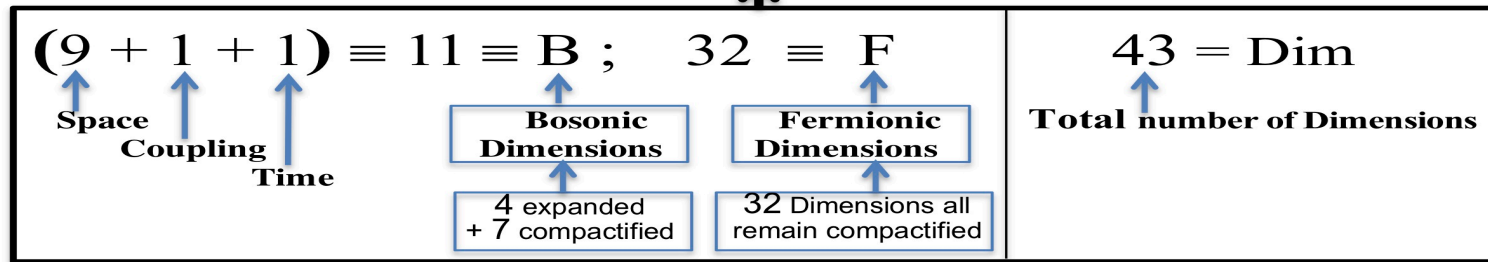
How QED + QFD + QCD
come into being

especially if Space-Time
has 43 dimensions (**Superworld**):

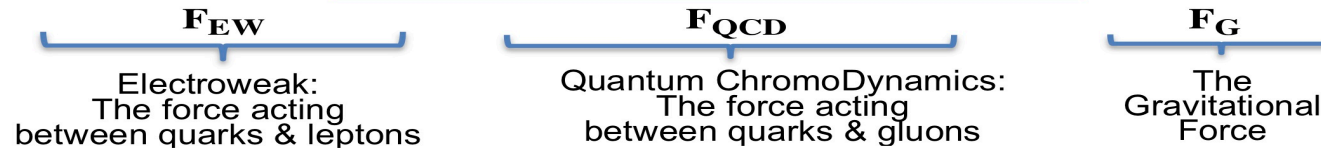
THE WHOLE OF OUR KNOWLEDGE, THE THREE BIG BANGS AND THE SUPERWORLD



THE SUPERWORLD

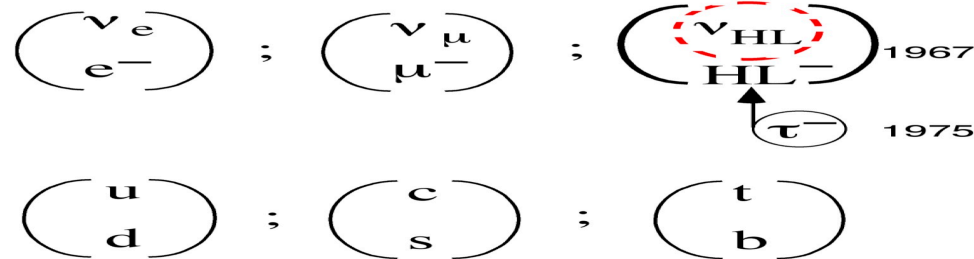


THE THREE FUNDAMENTAL FORCES



THREE GAUGE CHARGES, Q_G , FOR THE THREE FUNDAMENTAL FORCES

THREE COLUMNS OF LEPTONS AND QUARKS WITH TWELVE FLAVOUR CHARGES Q_f



TWELVE Q_f FOR THE THREE COLUMNS



SEVEN BASIC QUANTITIES

$c \neq \infty \equiv$ Fundamental Constant ; $\hbar \neq 0 \equiv$ Fundamental Constant

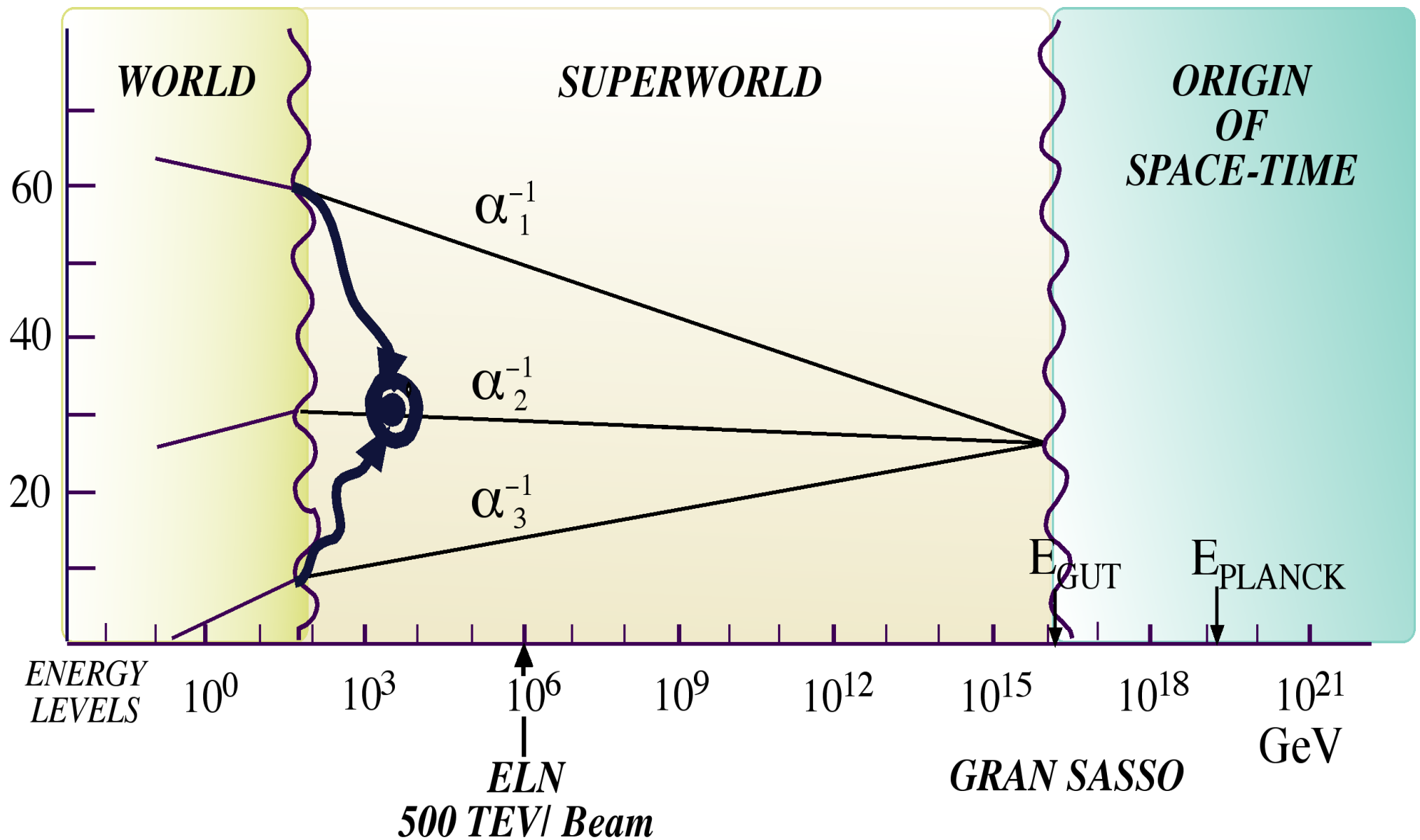
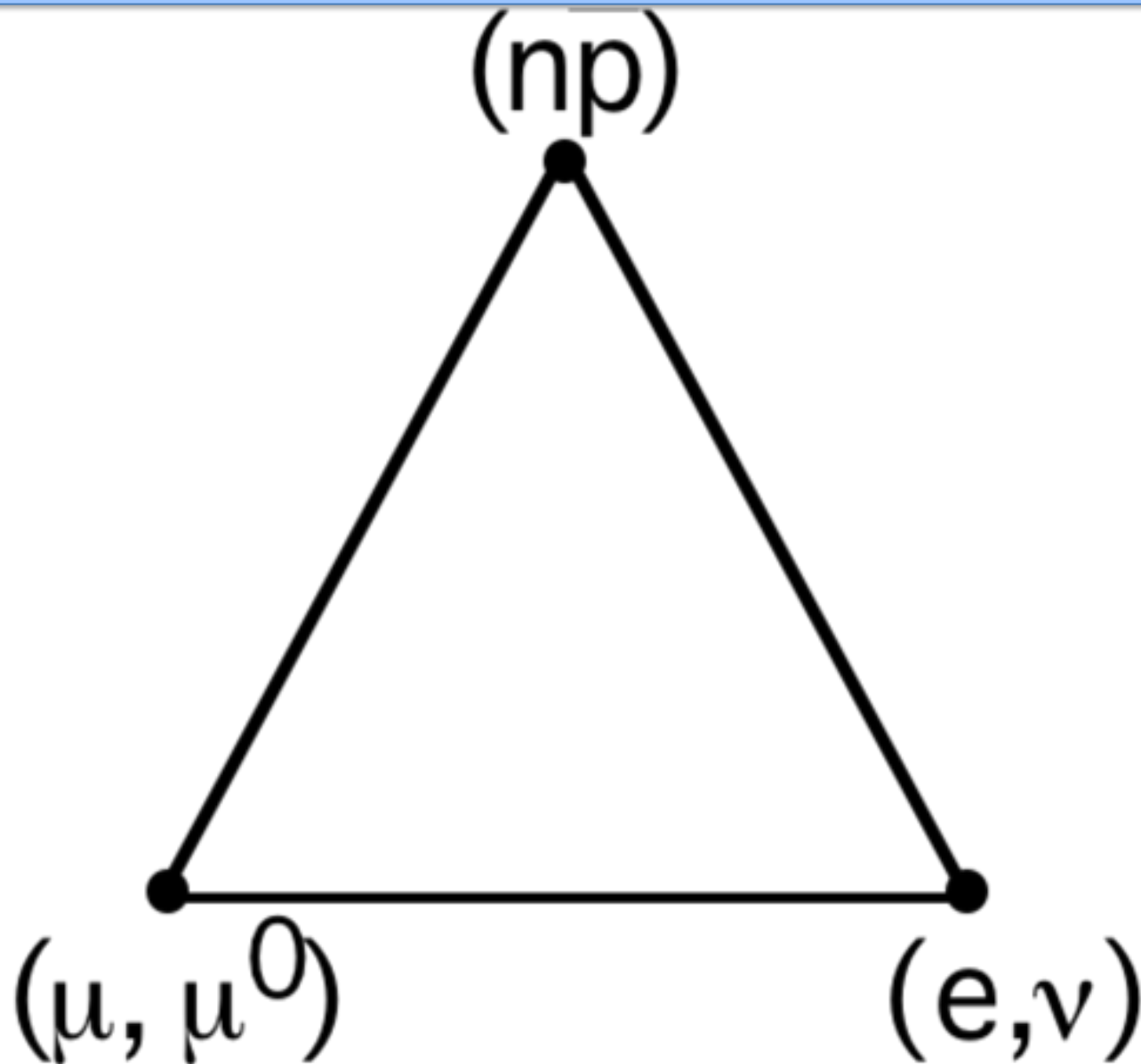


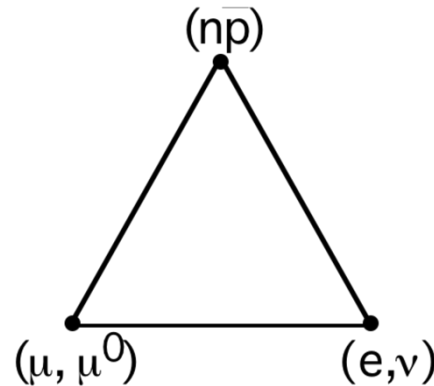
Figure 2

GIAMPIETRO PUPPI



THE PUPPI TRIANGLE

In his paper *Sui Mesoni dei Raggi Cosmici* (Nuovo Cimento **5**, 587, 1948) G. Puppi suggests that all Fermi processes could be described by the same coupling. In fact the decay rates of three different processes (π decay), (μ capture) and (μ decay) were found to be “approximately” the same. This is the origin of the Puppi triangle



where the three vertices allow, through their couplings, to describe all weak processes known at that time. Note that Puppi distinguishes the neutral counterpart of the muon, μ_0 (now known as ν_μ), from the neutral counterpart of the electron ν (now called ν_e). The existence of a second neutrino, i.e. $\nu_\mu \neq \nu_e$, was established in 1962 by L.M. Lederman, M. Schwartz, J. Steinberger and Collaborators at BNL [1]. The universality of the Fermi interactions attracted the interest of eminent physicists [2, 3, 4].

- [1] *Observations of High-Energy Neutrino Reactions and the Existence of Two Kinds of Neutrinos*
G. Danby, J.-M. Gaillard, K. Goulianos, L.M. Lederman, N. Mistry, M. Schwartz and J. Steinberger, *Phys. Rev. Lett.* **9**, 36 (1962).
- [2] *Mesons and Nucleons*
O. Klein, *Nature* **161**, 897 (1948).
- [3] *Interaction of Mesons with Nucleons and Light Particles*
T.D. Lee, M. Rosenbluth and C.N. Yang, *Phys. Rev.* **75**, 905 (1949).
- [4] *Energy Spectrum of Electrons from Meson Decay*
J. Tiomno and J.A. Wheeler, *Rev. Mod. Phys.* **21**, 144 (1949).

Enrico Fermi

quoted the Puppi Triangle
as a fundamental evidence
for the existence of
a new Fundamental Force:
the Weak Interaction.

As celebrated in this Symposium promoted by

WALTER TEGA:

**The greatest
discovery
in the XX Century
is
QED, QFD, QCD.**

QED → High precision $(g-2)_\mu$ (magnet)

QFD → High precision g_F

QCD → Confinement (no quarks at the highest energy (ISR))

Universality (Effective Energy)

Leading Effect

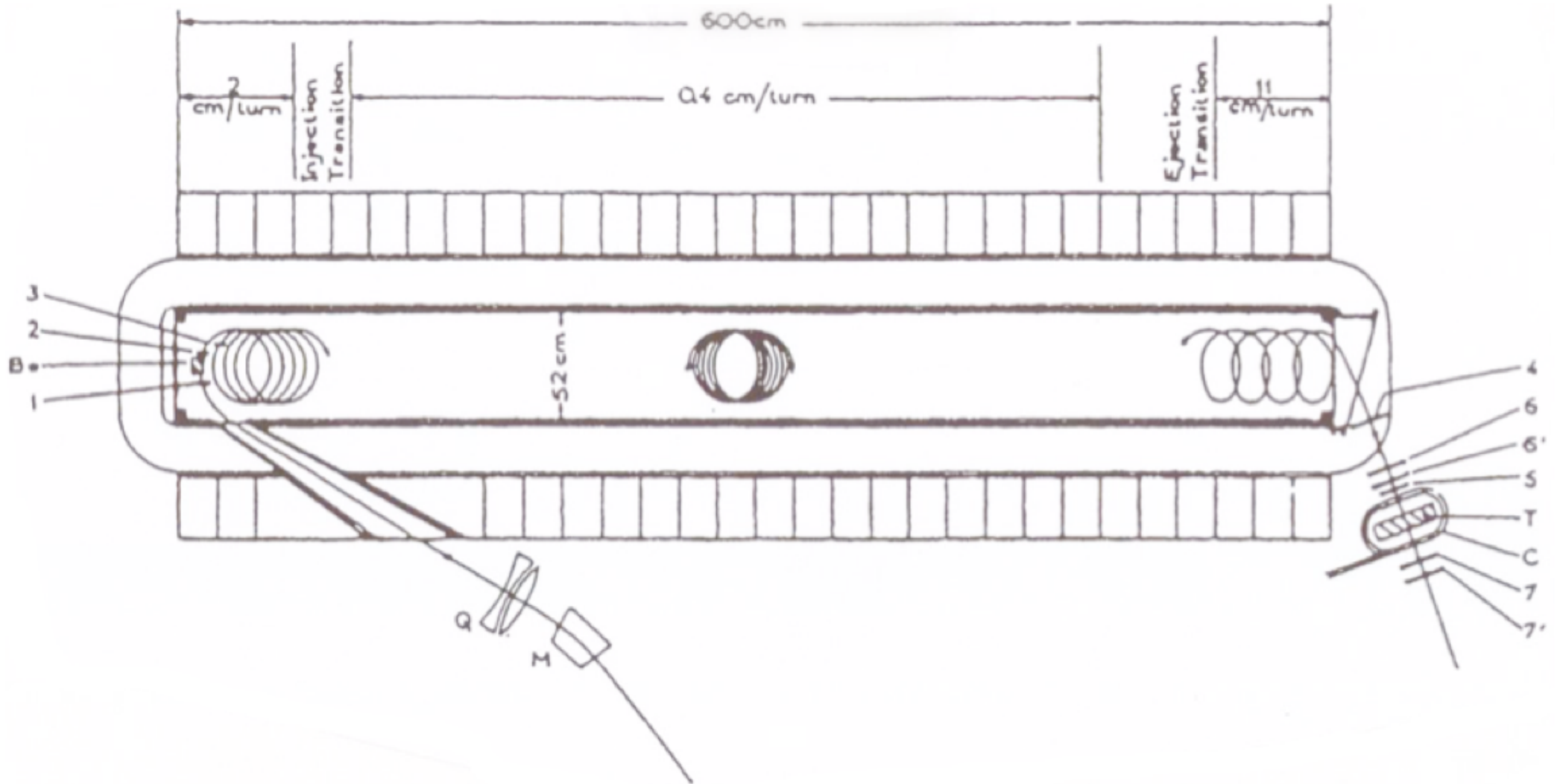


Figure 18: General plan of the 6-metre magnet. *M*: bending magnet; *Q*: pair of quadrupoles; 1, Be, 2, 3: injection assembly consisting of Be-moderator and counters 1, 2, 3; *T*: methylene-iodide target; counters 66', 77': "backward" and "forward" electron telescopes. A stored and ejected muon is registered as a coincidence 4, 5, 66' 7, gated by a 1, 2, 3 and by either a forward or backward electron signal.

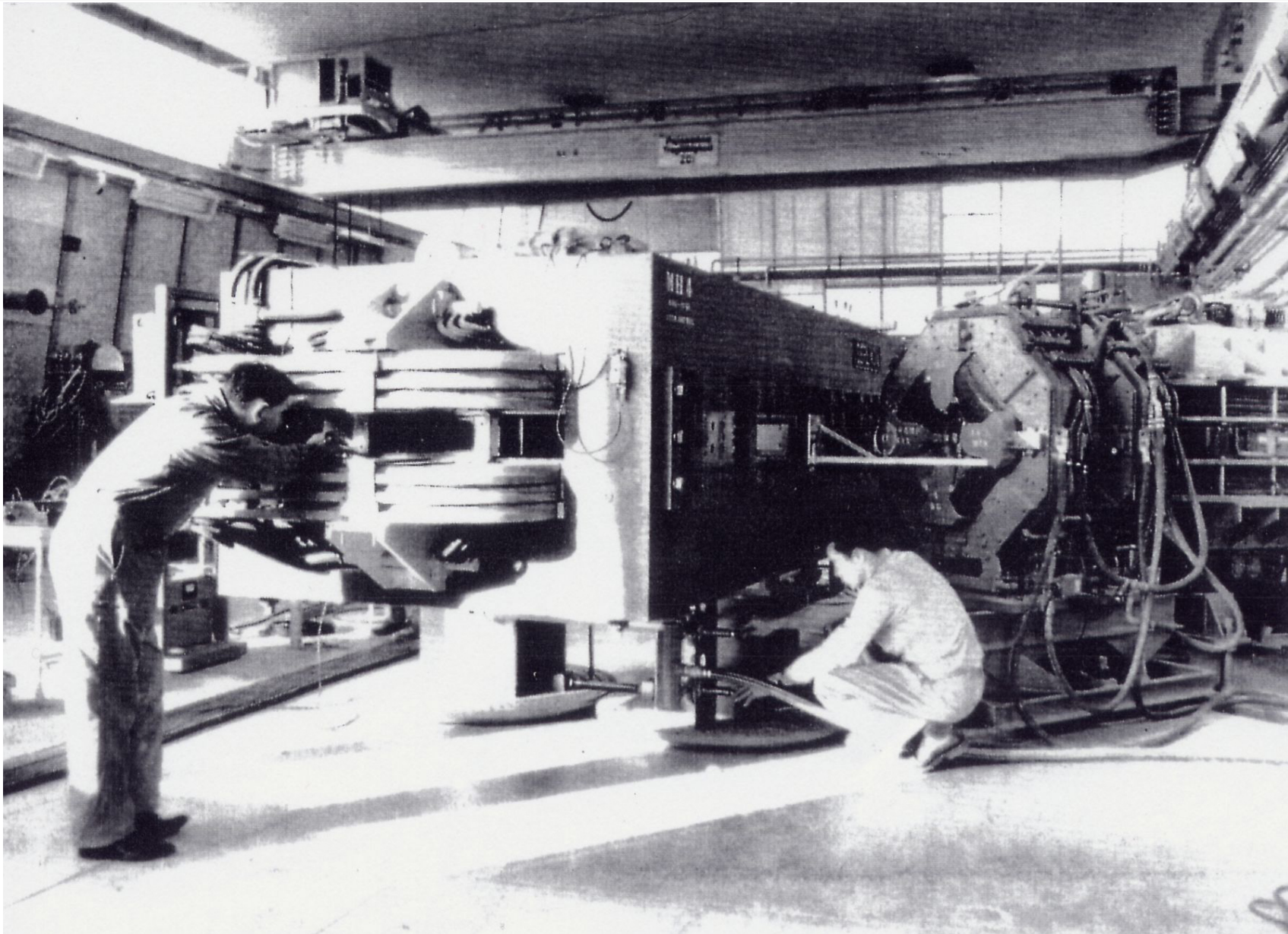


Figure 19: A photo of the six-metre “flat-magnet” where a sequence of high precision magnetic fields has been implemented using what Feynman liked to call the “trick” of the “shimming technology”.

Strong

$\left\{ \begin{array}{l} \pi p \\ K p \\ p p \\ p n \\ \bar{p} p \end{array} \right.$

EM

$\left\{ \begin{array}{l} \gamma p \\ e p \\ \mu p \\ e^+e^- \end{array} \right.$

Weak

νp

Without QED, QFD, QCD

⇒ Subnuclear Physics

neither the Gravitational Waves

nor the Higgs Boson

could have been discovered

World Scientific Series in 20th Century Physics – Vol. 24

SUBNUCLEAR PHYSICS

**THE FIRST 50 YEARS:
HIGHLIGHTS FROM ERICE TO ELN**

Antonino Zichichi

Edited by

O. Barnabei, P. Pupillo & F. Roversi Monaco

World Scientific

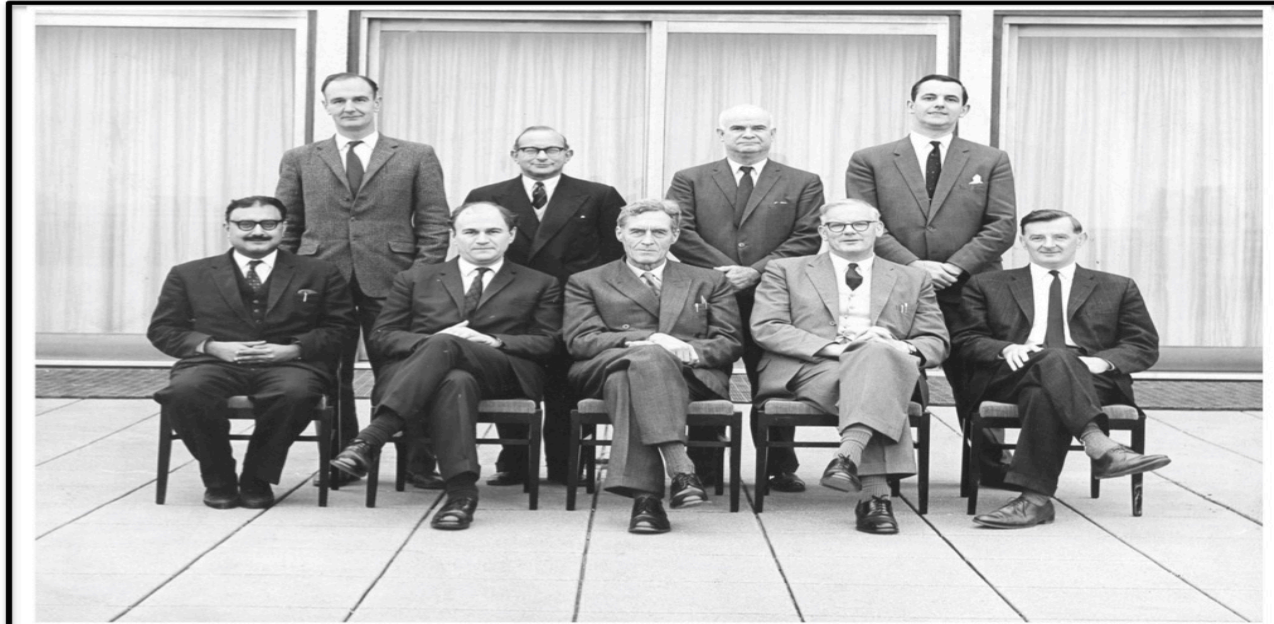
FERRETTI AND PUPPI

Ferretti and Puppi were
totally supporting the **idea**
that a **New Universe**
based on the
“strange” quantum number
HAD TO EXIST.

What about
Enrico Fermi criticism
on the absence of
 \oplus & \ominus Strangeness
for the same particle
?

**The answer had to be in the
experimental observation
of the same particle having**

Positive & Negative	Strangeness Quantum Number
--	---



(Picture courtesy of the Imperial College London)

Back row left:

Prof. P.T. Matthews, Prof. M. Blackman, Prof. J. McGee, Prof. Sir J. Mason

Front row left:

Prof. A. Salam, Prof. C.C. Butler, Lord P.M.S. Blackett, Prof. W.D. Wright, Prof. H. Elliott

Photo 4

G.D. James did not answer Gell-Mann’s objection. In my broken English I said that at production (10^{-23} sec) the θ^0 has $s = +1$ but, according to the most recent developments of our understanding of the physics of strange particles, the heavy meson θ^0 , later becomes a mixture of a meson with $s = +1$, θ^0 , and an antimeson, $\bar{\theta}^0$, with $s = -1$: ($\theta^0 \pm \bar{\theta}^0$). Due to my broken English, no-one really understood what I was saying. The chairman realized that I was defending the “discovery” and said: “Could you please come to the blackboard.” This gave me the chance to be understood by everybody since I was using equations not words, and the conclusion was me writing the correct reaction

$$\bar{\theta}^0 + n \rightarrow \Lambda^0 + \pi,$$

where the “strangeness” quantum number s was indeed conserved, since it

II-2 – HOW IT COULD HAPPEN THAT – FEW YEARS AFTER CERN WAS ESTABLISHED – THE DISCOVERY NEEDED FOR THE EXISTENCE OF THE "STRANGE" CHARGE WAS OBTAINED

It took me two years (from 1955 to 1957) to find two photos, where the pair production of heavy mesons (whose name from θ became K), with positive and negative strangeness, was experimentally proved to exist [5]. This was the first discovery at CERN, founded in 1954.

The front page of the paper [5] is reproduced in **Figure 2**.

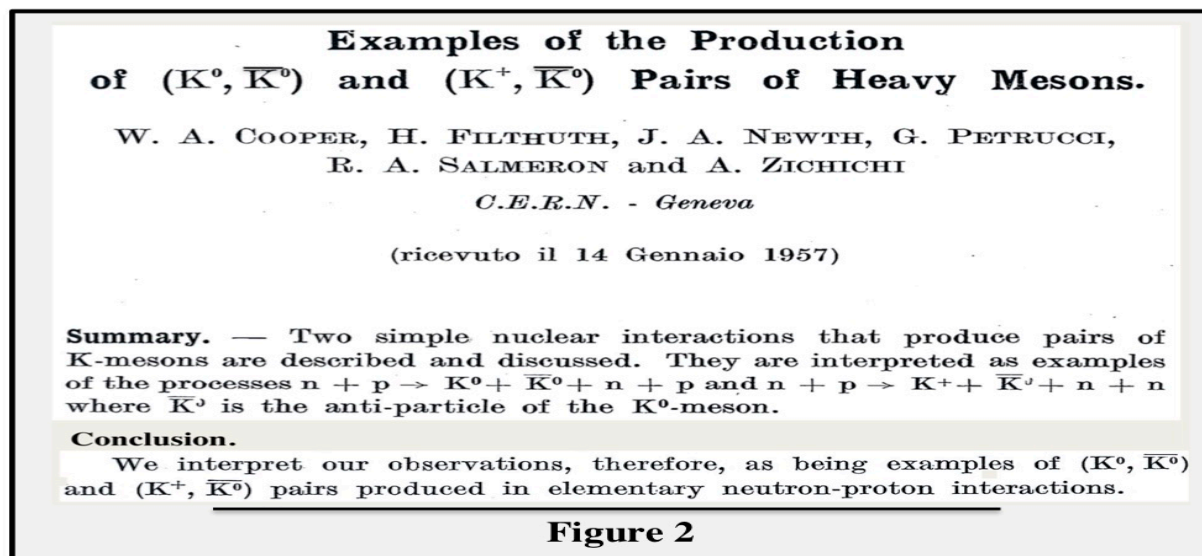


Figure 2

II – AN INCREDIBLE SEQUENCE OF UNEXPECTED EVENTS: THE BLACKETT, BOHR AND RABI "VITAL CONDITION" FOR CERN

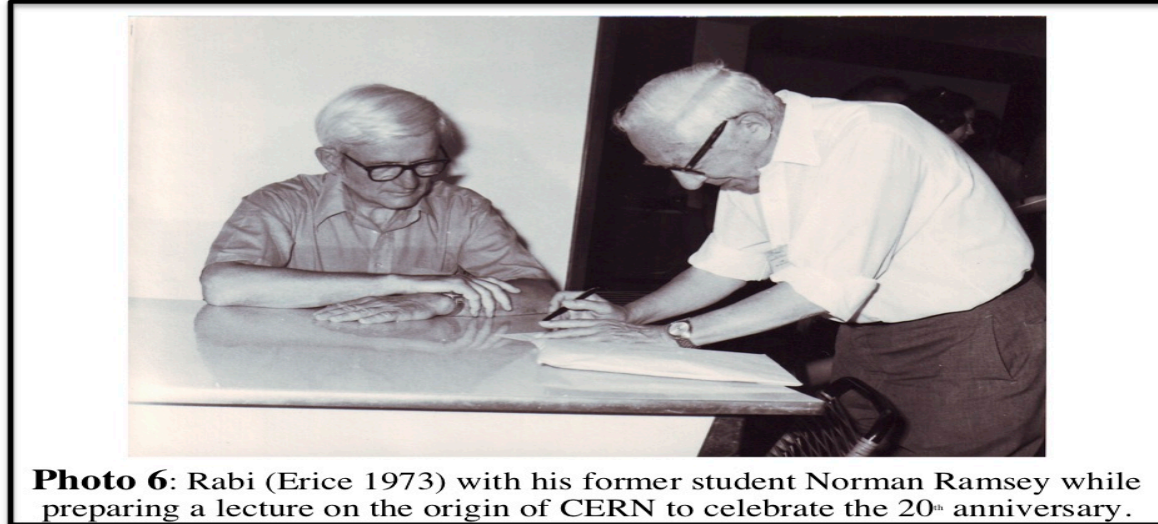


Photo 6: Rabi (Erice 1973) with his former student Norman Ramsey while preparing a lecture on the origin of CERN to celebrate the 20th anniversary.

Blackett offered his cosmic ray group, which was the most powerful in the world. Bohr who was responsible for getting the support of the Scandinavian Countries, considered the scientific activity for CERN a vital condition to start with. The results of the Blackett, Bohr and Rabi "*vital condition*" are in the Figure below (**Figure 3**).

**THE RESULTS OF THE BLACKETT, BOHR AND RABI
"VITAL CONDITION" FOR CERN**

- 1 – New Physics:** the discovery of pair production of heavy mesons with positive and negative "strangeness" (Chapter II-2).
- 2 – High Precision Physics:** the anomalous magnetic moment of the muon (Chapter III-3.1).
- 3 – The invention of a new technology** for the construction of polynomial magnetic fields (Chapter III-3.2).
- 4 – The 1st proof that CERN could compete** with well established famous Labs and win (Chapter III-3.3).

Figure 3

Before going on to the next chapter a synthesis of the 1947 events, where from all started is given in **Figure 4**.

**ATTENTION
PLEASE**

THE ROLE OF SCIENCE IN THE CULTURE OF OUR TIME

**THIS CULTURE
WAS UNTIL THE (3/4)
OF XX CENTURY
*1% MODERN AND
99% PRE-ARISTOTELIC***

PROOF

The Great Discovery of Nuclear Fission

was given as the proof that
Science produces weapons
 10^6 times more powerful than
all known weapons.

No Heads of State,
No Political Leaders
had
the courage and
the intellectual power of
DEFENDING SCIENCE

JOHN PAUL II
is the Pope who has
revived Science and
Scientific Culture

- Science \neq Technology
- Hiroshima & Nagasaki

- Science and Faith Gift of God
 - cm, gr, sec
 - c, h, GN

**The use
of Science
is no Science
but Technology**

L'uomo può perire per effetto della tecnica
che egli stesso sviluppa, non della verità che
egli scopre mediante la ricerca scientifica.

Joannes Paulus II

**«Man could perish from the effects of
technology that he himself develops,
not from the truth that he discovers
by means of scientific research».**

To defend science from the attacks of prevailing culture.

The Modern Culture has to distinguish Science from Technology

«The use of Science is not anymore Science; this is why Technology could either be beneficial or harmful to life's values and human dignity».

SCIENCE AND TECHNOLOGY:

to distinguish between major scientific discoveries and military technologies, unbridled industrialisation and genetic manipulation.

What about the values of Science?

Scienza e fede sono entrambe
doni di Dio.

Joannes Paulus II

«Science and Faith are both gifts of God».

To open the doors of the Church to Science.

**JOHN PAUL II
brought Science
and its values
to the same level
as the Faith**

What about the Proof ?

Before John Paul II
the basic structure of
Fundamental Units
were:

cm \Longrightarrow for Space (length)

gr \Longrightarrow for mass-energy

second \Longrightarrow for Time

After the
rebirth of Science the
Fundamental Units are:

$c \equiv$ *The velocity of light*

$h \equiv$ *Planck's Constant*

$G_N \equiv$ *Newton's Constant*

The three quantities
which never change
with Time.

For these Units it is as
if Time did not exist.

These quantities govern
the **Logic** of the Universe
(from the Subnuclear
to the one made
of Stars and Galaxies).

From this **Units**
the following values
come

10^{-33} *cm*

10^{-5} *gr*

10^{-44} *sec*

These values
are in the

Evolution of the Universe

from the first instant
to now.

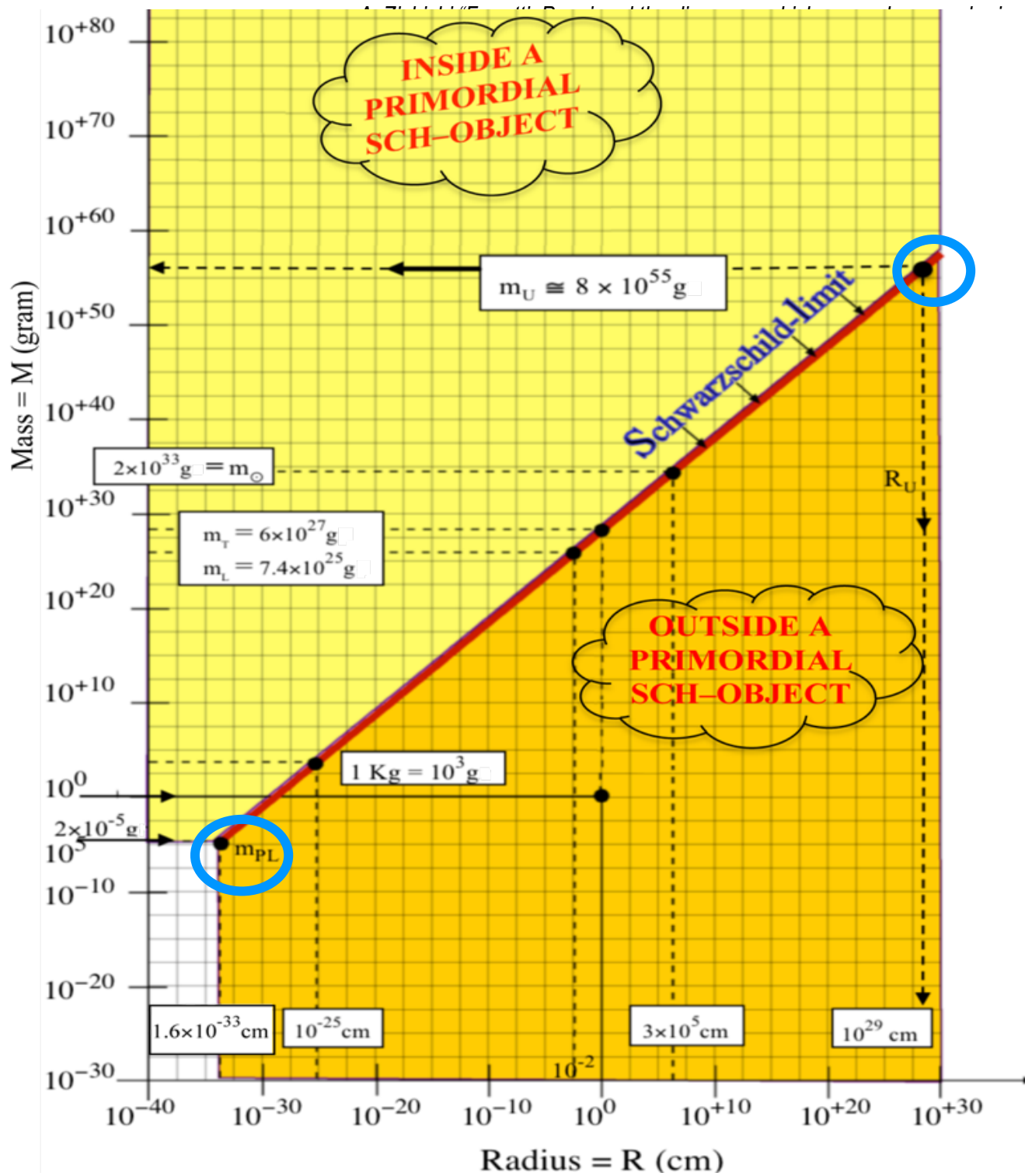


Figure 1: The Schwarzschild law between the radius of the gravitational horizon and the mass from the smallest to the largest SCH-object.

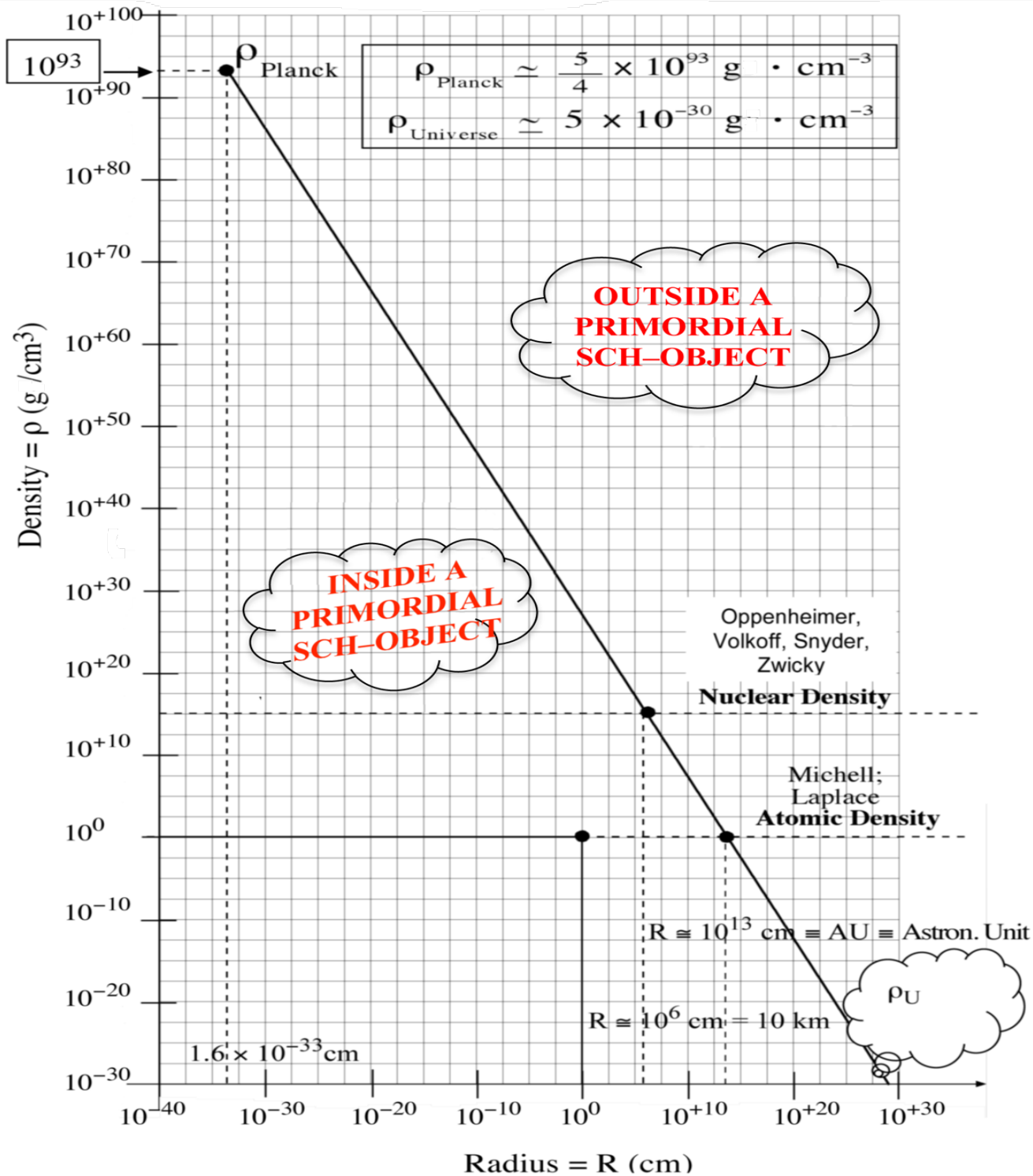


Figure 2: The relation which exists between the value of the SCH radius (R_{SCH}) and the corresponding density (ρ_{SCH}), from the smallest (the Planck Universe) to the largest SCH-object (the Universe now).

HOW THIS DID HAPPEN?

By an act of Intellectual Humility:

The recognition that
the **Author of the Logic of Nature**
is more intelligent than any of us –
philosophers, thinkers,
mathematicians, logisticians, scientists.

**These two graphs
could not have
been there without
the great achievements
of Galilean Science.**

John Paul II
rehabilitated
Galileo Galilei
who wanted to search
in the stones
the Imprints of the Creator

These graphs are the result
of the fact that it is not enough
to be Intelligent to discover the
Logic chosen by the One
who made the world.
It is necessary **to ask Him**
one question **at a time**
(REDUCTIONISM).

During 10^5 years all Civilizations
had sin of **intellectual**
arrogance:

Just be smart
to understand
the **Logic** that rules the world.

WE SCIENTISTS CANNOT REMAIN SILENT

when the great public is bombarded with topics such as:

- Complexity is the New Science
- The Reductionism is over. All Sciences must be Holistic
- The Artificial Intelligence will overcome the Human Intelligence
- Chaos is the origin of Life

- The global warming
- The energy crisis
- The information security
- The environment
- The Intelligent Design
- The Evolution
- and other Problems coming from the 'Whole of Our Knowledge'.

Now again
the Culture
of our Time
remains Silent.

The answer
must be
the
Whole of Our Knowledge
and the
mathematical rigour
needed to solve any problem.

The Whole of Our Knowledge
allows us to discover that
we are the only form
of living matter having
the privilege of **REASON**.
And the REASON
is a GIFT OF GOD.

GIFT OF GOD

REASON

- Permanent Collective Memory
(**Written Language**)
- Rigorous Theoretical Logic
(**Mathematics**)
- Rigorous Experimental Logic
(**Science**)

Thus confirming
what Science
has been able to discover
asking to the Creator
one question at a time.

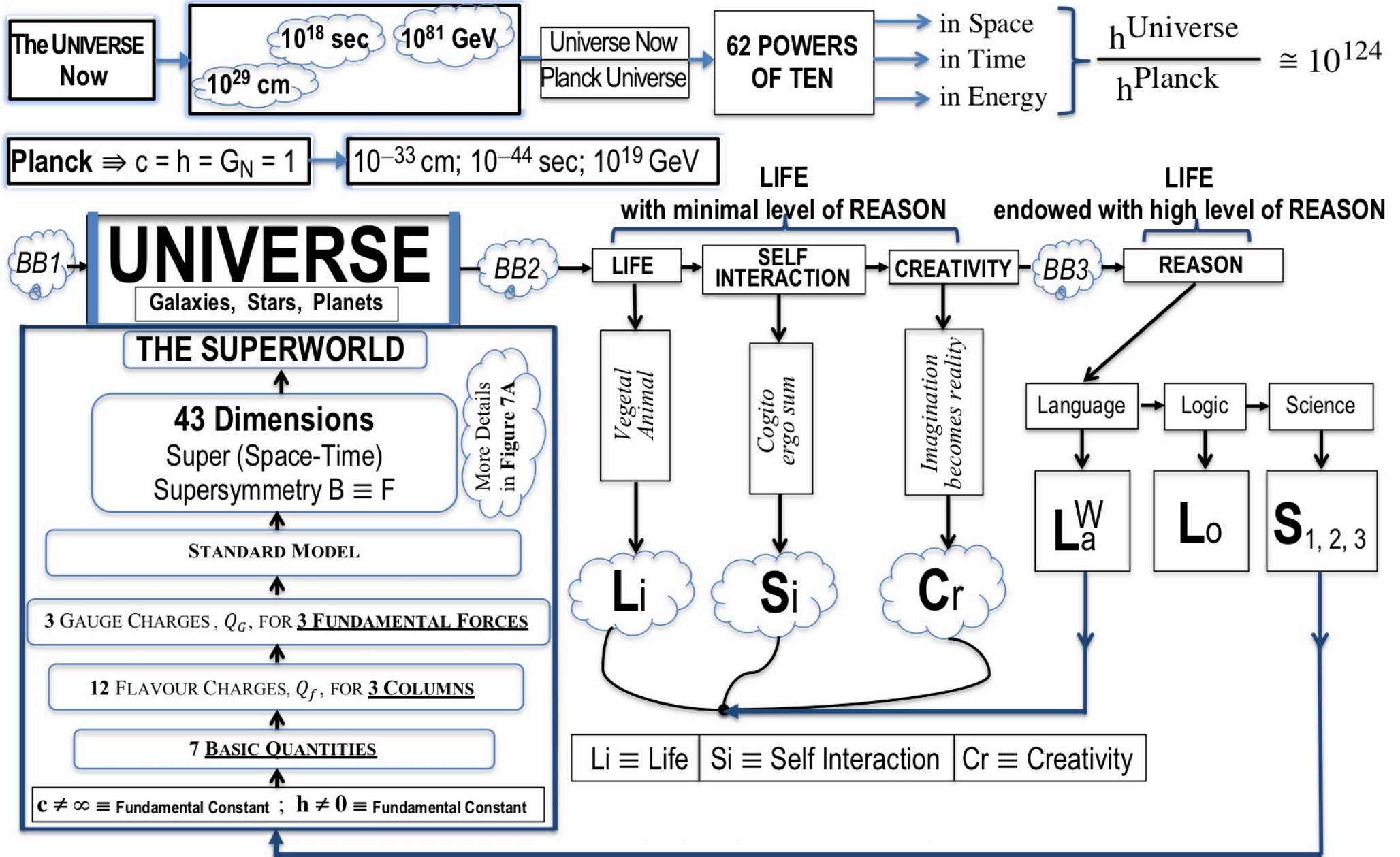
- Science \neq Technology
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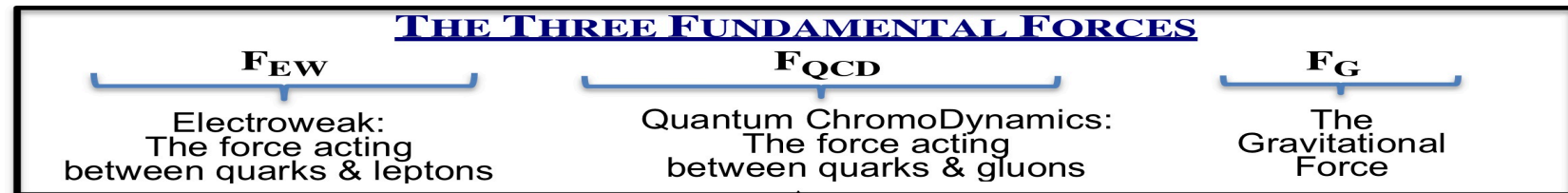
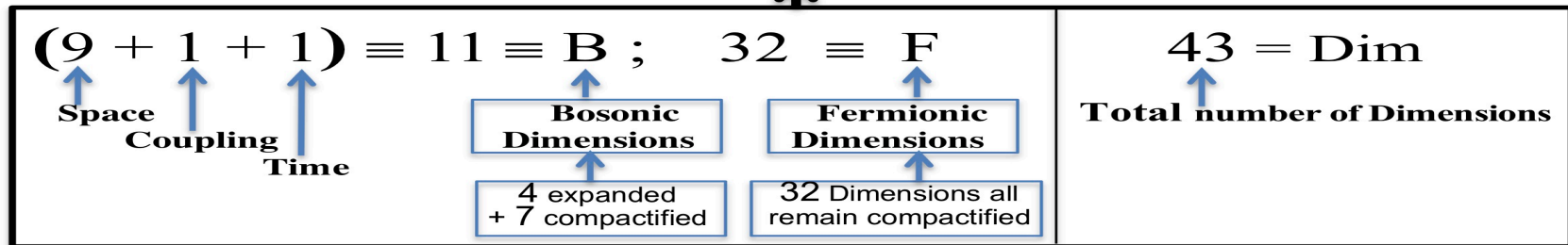
HOLISM
is not a New Science
but
the very old way of thinking
that we could discover
the Logic of Nature without
asking questions to the **Fellow**
who created the Universe.

The answer
must be
the
Whole of Our Knowledge
and the
mathematical rigour
needed to solve any problem.

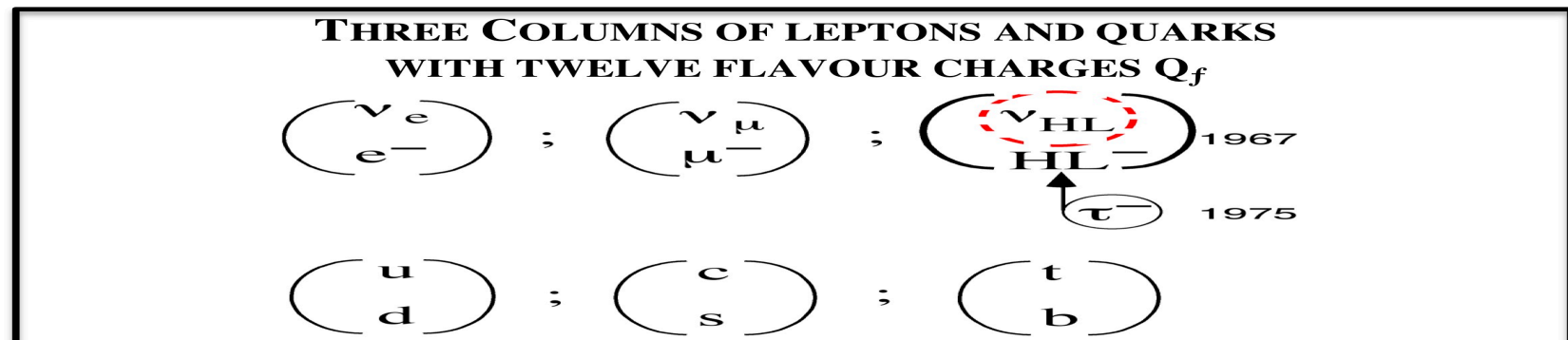
THE WHOLE OF OUR KNOWLEDGE, THE THREE BIG BANGS AND THE SUPERWORLD



THE SUPERWORLD



THREE GAUGE CHARGES, Q_G , FOR THE THREE FUNDAMENTAL FORCES



TWELVE Q_f FOR THE THREE COLUMNS



SEVEN BASIC QUANTITIES

$c \neq \infty \equiv \text{Fundamental Constant} ; \quad h \neq 0 \equiv \text{Fundamental Constant}$

With Holism
it would have been
impossible to get
The Whole of Our Knowledge
The Superworld

**Here
is the
Mathematics
needed**

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

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

μ is the fundamental variable such as Space, Time, Energy, etc.

This is a system of coupled non-linear differential equations in order to mathematically describe any phenomenon where quantities,

all functions of the variable μ ,
play a fundamental role.

MATHEMATICS →

72 Planetary Emergencies

**No Analytic Solutions
for the Climate**

END (*1st*)

**Thank you
for your attention**

A NOTE ON THE MATHEMATICAL DIFFICULTY OF CLIMATOLOGY

If the number of equations is more than two there is **no analytic solution**.

No one will be able to find an equation (for example like the Newton formula) to mathematically describe the **CLIMATE**.

Those who claim that they are able to do this are like the famous theoretical physicist who, in the middle of the XX Century, went to Enrico Fermi saying that he had a mathematical model which could explain all discoveries done in Nuclear Physics. Fermi asked him: “*How many free parameters there are in your model?*” The answer was: “*Many*”.

Fermi recalled him the von Neumann statement: *“If you allow me to have four free parameters I can build a model which describes an elephant. If you allow me a fifth 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.

END (*2nd*)

**Thank you
for your attention**

Our Universe comes from the Planck Universe (solution of Einstein's equation).

Ratio of Gravitational to Electromagnetic attraction between proton and electron

$$\simeq \frac{G_N \cdot m_p \cdot m_e}{e^2} \simeq 4 \cdot 4 \times 10^{-40}$$