

Is the LHC to Trigger a Scientific Revolution?

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What New Did We Learn About the Nature at This Workshop?

«*New Physics*»

[*C. Diez Pardos, M. Kirsanov, E. Sedykh, I. Tsukerman, D. F. Teyssier, I. Korolkov*]

- Superstring Resonances: **are not seen**
- Excited Quarks: **are not seen**
- Colorons: **are not seen**
- E_6 Diquarks: **are not seen**
- LeptoQuarks: **are not seen**
- Long-lived Massive Particles (SUSY): **are not seen**
- Axiguons: **are not seen**
- **Contact Quark interactions: are not seen**
- RS /KK gravitons, Black Holes, unusual Higgses etc : **we probably know at what level they will not be seen.**

« Old Physics »

[M. Jeitler, I. Tsukerman, S. Sadovsky,
Sobol, C. Roda, I. Korolkov]

« Standard » Standard (EW) Model: à la recherche du Higgs perdu

pQCD: describes dijet mass distribution without any need of exotica

npQCD: total absence of predictions

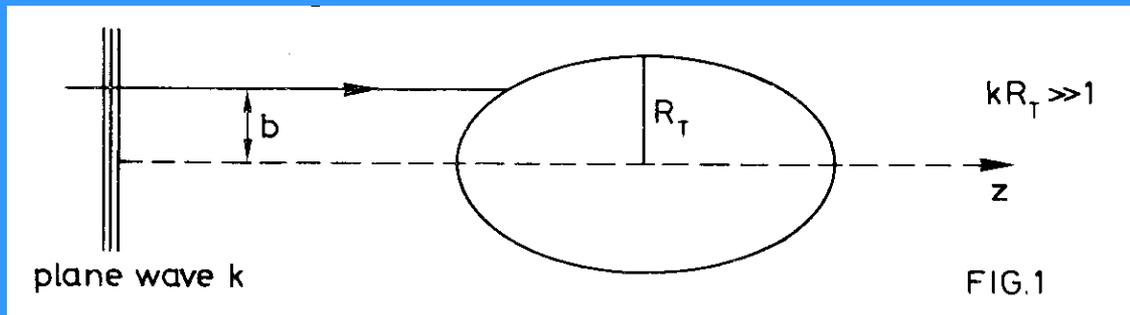
« Ridge »-like angular correlation effect : no doubts in QCD...but no unique explanation

QGP (Liquid?) : oh, yes, it is there (?)

Forward Physics: diffraction is seen, tot & dif Xsections wait for the TOTEM rising up

Important remark on diffractive physics: *this is a unique subject in the LHC Physics programme with use of high energies not to penetrate to smaller and smaller distances — quite opposite!*

INTERACTION REGION



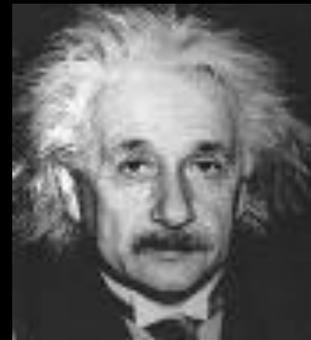
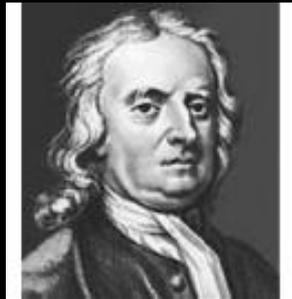
$$\Delta x_T \sim R_T \sim 1/\sqrt{\langle p_t^2 \rangle}$$

$$\Delta x_L \sim E_{cm}/\langle p_t^2 \rangle \sim 10^4 \text{ fm at the LHC}$$

$$\langle p_t^2 \rangle(\text{elastic}) \Rightarrow 0$$

Concise Survey of History of Physics

- Aristotle (IV BC) – the birth of the term “physics”: first dynamical (“peripathetic”) theory
- Kopernicus, Galileo, Kepler, Newton (XVI-XVII AC) – prophets of the first (mechanistic) revolution
- Faraday, Maxwell (XIX) – the concept of field
- Larmor, Lorentz, Poincaré, Einstein – relativistic revolution(XIX-XX)
- Planck, Bohr, Heisenberg, Schrödinger, Dirac – quantum revolution (XX, 1st third)



Evolution of Fundamental Physics

Thomas Kuhn: repeating changes of
PARADIGMS (παράδειγμα) = scientific revolutions.
PARADIGM is an unprecedented achievement which
1) attracts an enduring group of adherents away from
competing modes and 2) leaves all sorts of problems to
resolve.

Example: theory of light

Newton's Paradigm : light consists of corpuscles

Hyugens- Young- Fresnel's Paradigm: light is waves

Planck-Einstein-Stark's Paradigm: light consists of corpuscles

Bohr's Paradigm: light is neither particles nor waves

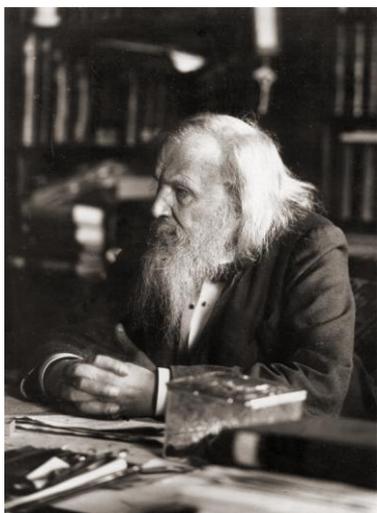
(this is actually a consequence of the Quantum Paradigm)

Modern fundamental physics = combination of Quantum and Relativistic Paradigms

- Concrete realization :

Standard Model of Electroweak and Strong Interactions

Novel Feature: “masses without masses”-
Higgs “mechanism”



Mendeleev Table of Elements

Periodic Table
of the Elements

1A																	0	
1	1 H															2 He		
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	+Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113					

* Lanthanide Series

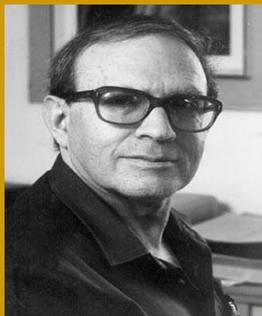
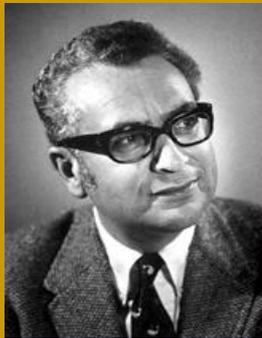
58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

+ Actinide Series

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

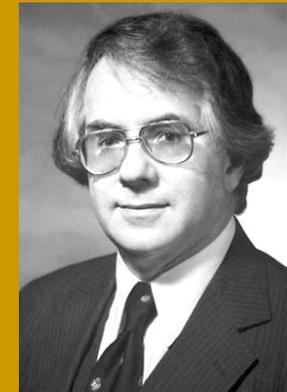
“Mendeleev Table” of the SM

36 world’s elements



Three Generations
of Matter (Fermions)

	I	II	III	
mass →	2.4 MeV	1.27 GeV	171.2 GeV	0
charge →	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0
spin →	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
name →	u up	c charm	t top	γ photon
	4.8 MeV	104 MeV	4.2 GeV	0
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	0
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
Quarks	d down	s strange	b bottom	g gluon
	<2.2 eV	<0.17 MeV	<15.5 MeV	91.2 GeV
	0	0	0	0
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	Z weak force
	0.511 MeV	105.7 MeV	1.777 GeV	80.4 GeV
	-1	-1	-1	± 1
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
Leptons	e electron	μ muon	τ tau	W[±] weak force



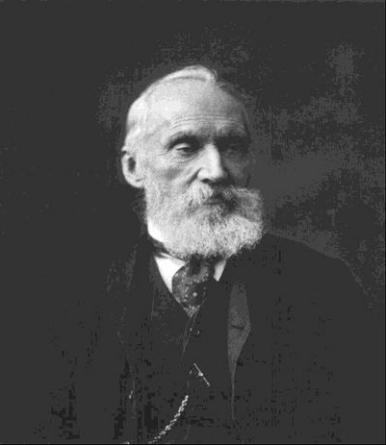
Missing Element: Higgs Boson

If Arising of the SM Is a Scientific Revolution?

- The SM is undoubtedly a great achievement. The distinctive feature: symmetry dominates the structural composition of matter.
- Is this achievement “unprecedented”?

With all respect to its creators and without any diminishing of its significance, NO.

Reasons: both previous fundamental paradigms - quantum and relativistic - remain intact and basic. Psychological impact of the SM is incomparable to RT and QM



Lord Kelvin (1900): "there are only two little clouds in the sky of physics"

“Two little clouds” (relativity and quantum principles) now dominate the whole sky of modern physics.

Is elusive Higgs boson such a “little cloud” ?

Will the SM survive without the Higgs ?

Option: the SM contains a germ of a new paradigm and a new scientific revolution.

New Horizons

“Superstring revolution” (1984 -1986)



Revolution without a revolutionary situation ?

Is there a real **CRISIS in modern physics?**

Radical Change of Basic Notions

- 0-dimensional (point) \rightarrow 1-dimensional (“string”)
- N of space-time dimensions: $3+1 \rightarrow 10+1$
- Grassmanian (fermionic) dimensions of the Superspace

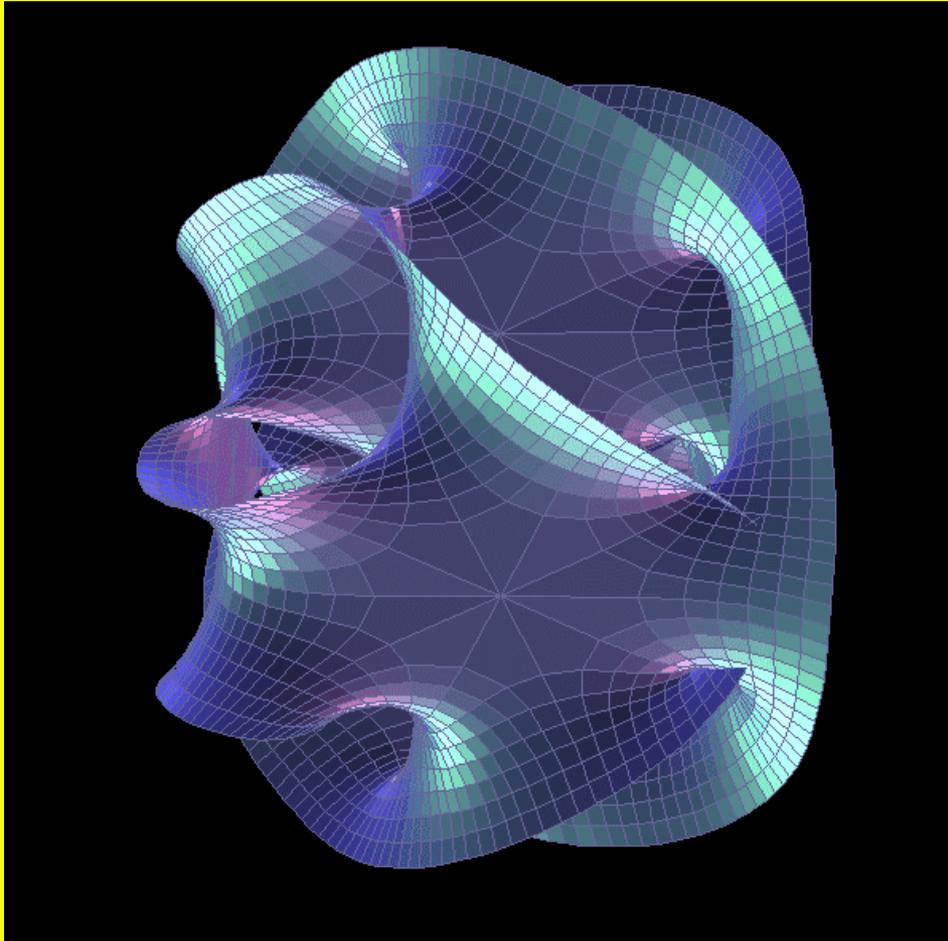
Motivations:

Experimental: none

Theoretical: unification of ALL interactions
including gravity

Aesthetic: no free parameters,
absolute uniqueness

What Is the “String”?



Symbol of Faith: Superstring Theory Is the Ultimate Truth in Physis

Corollary: Superstring theory is

The THEORY of EVERYTHING

“Everything” is but an excitation of the superstring

Prospect for achieving the absolute truth

Corollary: the end of physics

Corollary: the end of science

Simple-minded question: what superstring consists of ?

Answers: “Superstring consists of the direct product of four-dimensional Minkowski space-time with a compact six-dimensional, Ricci-flat, Kähler manifold of SU(3) holonomy (Calabi-Yau manifold)...”

or “Superstring consists of infinitely many super- points...”

Or even ...”

strings are purely mathematical objects, made of logical axioms.

“!!!

What Adversaries/pessimists Think?

- Superstring theory is NOT EVEN WRONG!
- Superstring “revolution” dures too long: almost 40 years.
- **SUPERSTRING THEORY IS BUT A NEW METAPHYSICS: it needs no experiments at all.**

The very idea of TOE contradicts to Gödel's Incompleteness Theorem: no consistent system of axioms whose theorems can be listed by an "effective procedure" (essentially, a computer program) is capable of proving all facts about the

Theory of Everything



Conclusions

- **All of you are participants of the events of a (quite probably) historic scale**
- **The search for the Higgs at the LHC is an *experimentum crucis* for the Standard Model**
- **If the Higgs is not found we have a chance to be witnesses (and active participants!) of a scientific revolution**
- **Superstring revolution in spite of all criticism may be fairly on the list**

Trivial but non-negligible:

**SR can be triggered by some unexpected ,
extraordinary effects at the LHC**

First follow Nature, and your judgment frame

By her just standard, which is still the same;