Tini in Madrid

Martinus Veltman 80th birthday

Amsterdam, June 24th 2011

Belén Gavela
Universidad Autónoma de Madrid (UAM) and IFT

*** Tini is loved in Madrid’s UAM, as a physicist of course...... and as a friend!**

- He has visited often, given many talks, and taught in our master and doctorate programs in Theoretical Physics (last “official” teaching in the master courses in 2007)

- He has helped us repeatedly with grants and what not

- He has hold a permanent UAM ``catedrático visitante” position (visiting full professor) from October 1988 until end Juin 1996.


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Investigadores "Ramón y Cajal"
Contratados Posdoctorales e Investigadores "Juan de la Cierva"
Profesores Visitantes y Honoríficos
Profesores Ayudantes
Estudiantes de Doctorado
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Docentes no-UAM (Másters y Apoyo)
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Tuca


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Jos Vermaseren


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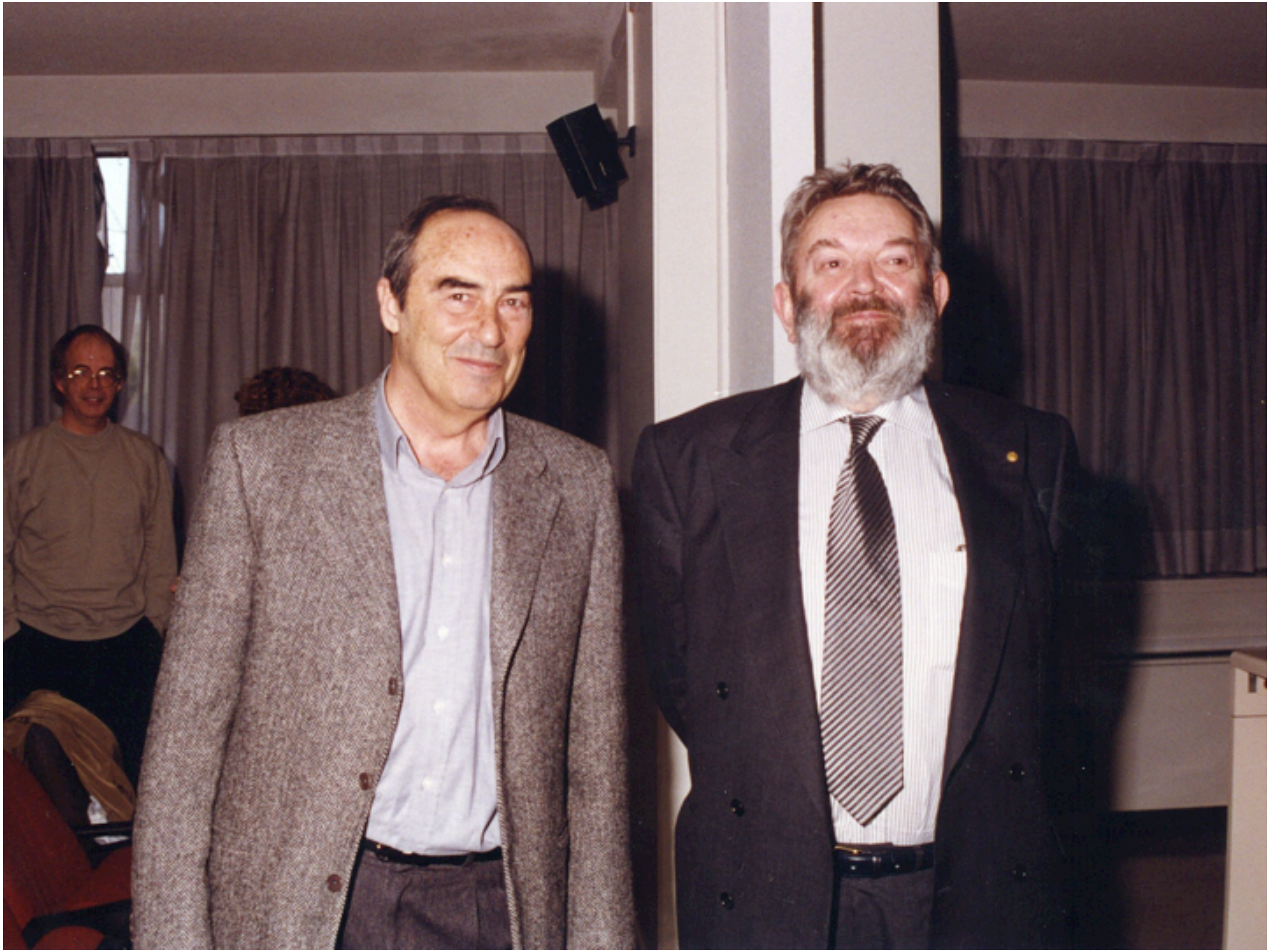
Former senior professors

Former senior professors

Indeed they had fun



They had fun in many ways, i.e.

Tini's Diagrammatica, page 181:

Yndurain interaction

* Left Handed photons :-)

... photons. This is actually possible by using in the interactions exclusively the combination $F_{\mu\nu} + \tilde{F}_{\mu\nu}$ where $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$, and $\tilde{F}_{\mu\nu} = \epsilon_{\mu\nu\alpha\beta} F_{\alpha\beta}$. We will show how that works on the example of the Yndurain interaction (photon interacting with muon and electron):

$$\mathcal{H}_Y = -\frac{g}{2}\left(F_{\mu\nu} + \tilde{F}_{\mu\nu}\right)\left(\bar{\psi}_\mu \sigma^{\mu\nu} \psi_e\right) = g A_\mu \partial_\nu \left(\bar{\psi}_\mu \sigma^{\mu\nu}(1-\gamma^5)\psi_e\right).$$

One must add the hermitian conjugate interaction, but we will concentrate on this vertex. In the above σ is the usual antisymmetric combination of two γ-matrices. The interaction is gauge invariant, and it leads to the vertex factor

$$-\frac{ig}{4} k_\nu \left(\gamma^\mu\gamma^\nu - \gamma^\nu\gamma^\mu\right)\left(1-\gamma^5\right) \equiv -\frac{ig}{4} X_\mu .$$

We will show that the interaction multiplied with the propagator expression for the other photon (that is thus the ...

Nuclear Physics B325 (1989) 1–17
North-Holland, Amsterdam

They worked together

RADIATIVE CORRECTIONS TO WW SCATTERING

M.J.G. VELTMAN

Randall Laboratory of Physics, University of Michigan, Ann Arbor, MI 48109, USA

F.J. YNDURÁIN

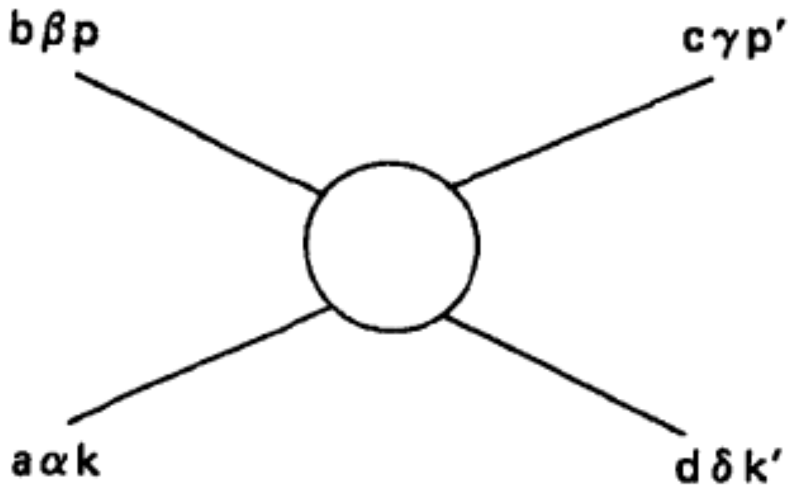
Departamento de Física Teórica, Universidad Autónoma de Madrid, E-28049 Madrid, Spain

Received 15 March 1989

The one-loop radiative corrections to vector-boson–vector-boson scattering are calculated in the limit of high energy and even higher Higgs mass. To parametrize the limit of large Higgs mass a new particle, the U-particle is introduced.

They analyzed the subtleties of $m_H \to \infty$.

Longitudinal WW scattering



They say:

. As far as we know, upper bounds on m_H are not particularly meaningful, being based upon perturbation theory which, precisely, fails if m_H is large.

They analyzed the subtleties of $m_H \to \infty$.

** They introduced a new unknown **U particle : a scalar SM singlet**, to illustrate it.*

Besides the ordinary W- and Higgs particles, and their interactions, we will introduce a scalar particle that we will call U, assumed to be a singlet under SU(2) and therefore not coupled to the W. The U allows us to control the limit of very large Higgs mass in the following way. If we couple U to the Higgs with a strength proportional to m_H^2, then it will still contribute to WW scattering at the one-loop level with terms quadratic in s, t, u.

They analyzed the subtleties of $m_H \to \infty$.

** They introduced a new unknown **U particle : a scalar SM singlet**, to illustrate it.*

$$\mathcal{L}_{\rm inv} = -\tfrac{1}{4}G^a_{\mu\nu}G^a_{\mu\nu} - \tfrac{1}{2}M^2W^2 - \tfrac{1}{2}(\partial_\mu H)^2 - \tfrac{1}{2}m^2H^2 - \tfrac{1}{2}(\partial_\mu\varphi^a)(D^a_\mu\varphi)$$

$$+ \tfrac{1}{2}gW^a_\mu(H\partial_\mu\varphi^a - \varphi^a\partial_\mu H) - \tfrac{1}{8}g^2W^2_\mu(\varphi^2 + H^2) - \tfrac{1}{2}gMW^2H$$

$$- rMgH(\varphi^2 + H^2) - \tfrac{1}{8}rg^2(\varphi^2 + H^2)^2 - M\varphi^a\partial_\mu W^a_\mu - \tfrac{1}{2}(\partial_\mu U)^2$$

$$- \tfrac{1}{2}m^2_{\rm u}U^2 - gg_{\rm u}rMU^2H - \tfrac{1}{4}g^2g_{\rm u}rU^2(H^2 + \varphi^2),$$

$r = m^2/4M^2$, H is the Higgs field, and φ^a the Higgs ghost triplet.

** H and U couple proportionally to m_H^2*

They analyzed the subtleties of $m_H \rightarrow \infty$.

If $m_U = m_H$ and we let $m_H \rightarrow \infty$, the U particle becomes utterly invisible: but with its inclusion the one-loop corrections to WW scattering can be altered. This shows clearly arbitrariness in the limit $m_H \rightarrow \infty$.

And later comes a jewel:

Besides its use as a theoretical artifact, the U stands for objects that only couple to ordinary matter via the Higgs (and presumably gravity). If $m_U^2 \ll s$ the U may be produced really (and copiously) in WW collisions. The one-loop corrections to this process could well be the only indications of the existence of U-like particles, other than their gravitational effects. There is a large domain of speculation here that we prefer to leave to the appropriate experts*.

*** See the proceedings of any conference on dark matter or other exotic subjects.**

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These guys had indeed fun... and were seminal!

Tini and Paco...... Dark Matter pioneers !

**** A scalar singlet coupled to Higgs, with a Z_2 symmetry, is a popular DM candidate ! It is recognized as Veltman-Yndurain U***

They analyzed the subtleties of m_H

** They introduced a new unknown* ***U particle : a scalar SM singlet***

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$r = m^2/4M^2$, H is the Higgs field, and φ^a the Higgs ghost triplet.

** It is quadratic in U*

This is different from Van der Bij's scalar singlet:

Can we miss the Higgs at LHC ?

THE VAN DER BIJ MALEDICTION

* 1980 Van der Bij + A. Hill

resurfaced in Moriond 2010 disguised as:
- NMSSM
- Gaugephobic
- Unhiggs
- Effective ops.

Gavela-Moriond summary 2010

In1980:

Extended standard model (with A. Hill)[†]

Van der Bij

Higgs-sector

Higgs doublet

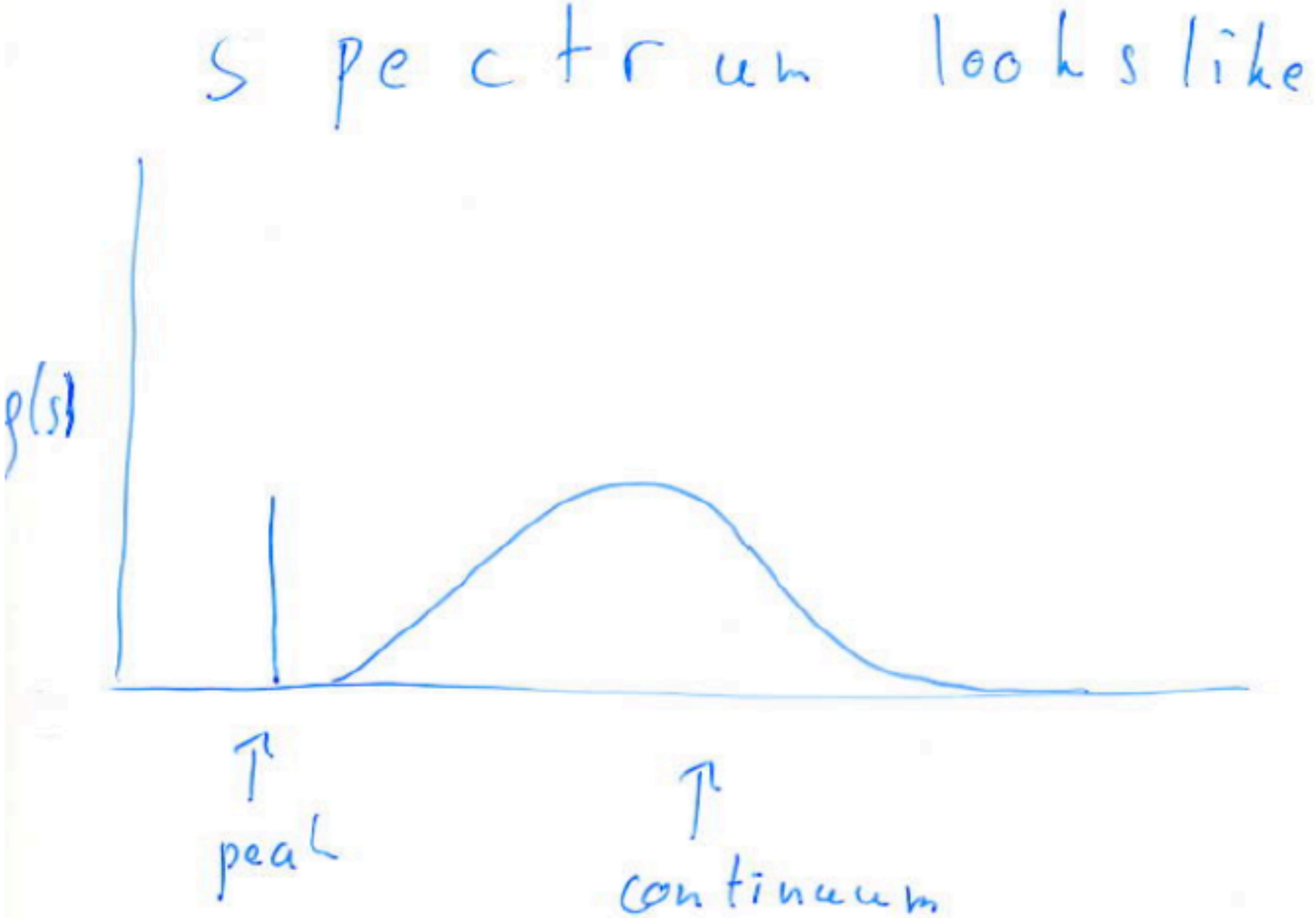
$$\mathcal{L} = -\frac{1}{2}(D_\mu \phi)^+(D^\mu \phi) - \frac{\lambda_1}{8}(\phi^+\phi - f_1^2)^2$$

$$-\frac{1}{2}(\partial_\mu x)^2 - \frac{\lambda_2}{8}(2 f_2 x - \phi^+\phi)^2$$

Scalar singlet

$$M_W = \frac{g f_1}{2}$$

Van der Bij Moriond 07: instead of one state, many ?



Tini+Paco's scalar is different: Z_2 symmetry

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U *U --> -U symmetry*

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Renamed S S --> -S *symmetry*

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Renamed S S --> -S *symmetry*

- "Scalar phantom" : (Silveira and Zee)
  - --> relic abundance from thermal freeze-out
  - --> direct detection from scattering off baryons
  - --> effect on Higgs decay
  - --> impact on cosmic rays

- Extension to complex singlet scalars: (McDonald)
  - --> cosmology, direct detection

- One real singlet scalar: (Burgess, Pospelov, Veldhuis)
  - ->collider searches via anomalous Higgs decays
  - -> dark matter self-interactions
  - -> constraints from singlet potential

Tini and Paco…… Dark Matter pioneers !

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….. and this became the "New Minimal SM" (Davoudiasl, Kitano, Li)

-> LHC studies (O'Connell, Ramsey-Musolf, Wise) (Barger et al.)

-> first order EW phase transitions---> baryogenesis (Pietroni) (Profumo et al.)

-> cosmic ray anomalies if TeV range (Ponton, Randall) (Kadastik et al.)

- Very recently: --> interpretation of DAMA, CDMS and CoGeNT anomalies

--> singlet scalar DM for Fermi (LAT) data

--> pair annihilation into two monochromatic high-energy gammas SS -> $\gamma\gamma$ (Profumo, Ubaldi, Wainright 2010)

(Andreas, Hambye) , (He, Li), (Farina, Pappadopulo, Strumia)…..

Celebrations in the lab

Fun together in Paco's fest

Everyday's life in the lab with Tini

*** Tini's influence in seniors and students, in physics:**

A recurrent theme, yesterday and today: his obsession with non-understanding gravity

Everyday's life in the lab with Tini

*** Tini's influence in seniors and students, in physics and beyond:**

-- He was a symbol with his "home-made" computer,
working on SCHOONSHIP

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--i.e. early 90's PhD student Juan Terrón (now senior ATLAS):
"I hope that when senior I will work like him, passionately
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-- Lunch time! : "which senior will be Tini's paunching ball today?"

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*** And influence ON Tini??**

-- Subtle change over the years wrt women physicists....

Tini enjoying...or suffering teaching?

Master in Theoretical Physics 2007

The Higgs Boson


The B fields are related to the W, Z0 and A fields. In fact B3 and B8 are
certain mixtures of Z0 and A and
From the point of view of the Higgs sector
In that case there would have been 6 vector bosons
However, Nature uses
There are 4 vector bosons of which one

Fun in everyday's life in Madrid??

Tini often stayed at the
"Residencia de Estudiantes"

Fun in everyday's life in Madrid??

Tini often stayed at the "Residencia de Estudiantes"

-> It was the home to **Garcia Lorca, Salvador Dali, Luis Buñuel** and other poets, intellectuals and scientists like **Severo Ochoa**, in the spanish republica in early XXth century. Visitors included **Albert Einstein, Paul Valéry, Marie Curie, Igor Stravinsky, John M. Keynes, Alexander Calder, Walter Gropius, Henri Bergson** y **Le Corbusier**, who honored it with their presence... and **Tini** joined them in this task.

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-> It remains a vibrant home-pensionnat for intellectuals and scientists of all areas, in central Madrid.... with peculiar senior old-style ladies running the dining-rooms and with fun surroundings.

A personal touch

The Self-Couplings of Vector Bosons: does LEP-1 obviate LEP-2?

A. De Rújula, M.B. Gavela, P. Hernandez* and E. Massó†

Theory Division, CERN
CH-1211 Geneva 23, Switzerland

ABSTRACT

Theories beyond the standard model ("meta-theories") are severely constrained by the current body of data and must necessarily respect, we insist, the standard gauge symmetry. We analyze the constraints on two generic types of meta-theory, in which fundamental scalars do or do not exist. The novel low energy effects may be comprehensively described by grafting onto the standard Lagrangian new operators that –in the sense of a Taylor expansion– ought to form a complete set. Completeness calls for consideration of previously discarded operators, and for a thorough exploitation of the equations of motion. We illustrate the current strictures by focusing on the allowed range of departures from the most crucial, untested, precise standard prediction: the size and structure of the triple gauge-boson vertices. We conclude that their direct measurement at LEP-2 is, alas, most unlikely to provide new information.

DEDICATED TO MARTINUS (TINI) VELTMAN ON HIS $60^{th}\frac{1}{2}$ BIRTHDAY.

The self-couplings of vector bosons:
does LEP-1 obviate LEP-2? *

A. De Rújula, M.B. Gavela, P. Hernandez [1] and E. Massó [2]

Theory Division, CERN, CH-1211 Geneva 23, Switzerland

Received 31 October 1991
Accepted for publication 8 May 1992

Theories beyond the standard model ("meta-theories") are severely constrained by the current body of data and must necessarily respect the standard gauge symmetry. We analyze the constraints on two generic types of meta-theory, in which fundamental scalar do or do not exist. The novel low-energy effects can be comprehensively described by grafting onto the standard lagrangian new operators that – in the sense of a Taylor expansion – form a complete set. Completeness calls for consideration of previously discarded operators, and for a thorough exploitation of the equations of motion. We illustrate the current strictures by focusing on the allowed range of departures from the most crucial, untested, precise standard prediction: the size and structure of the triple gauge-boson vertices. We conclude that their direct measurement at LEP-2, while phenomenologically very interesting, is, alas, unlikely to provide new information.

1. Introduction

A precise measurement of the electron or muon magnetic moment in agreement with the QED prediction has two redeeming values. First, and to the incomprehensible dismay of the experimentalist, it tests the theory. Second, and not to the delight of the model-builder, it excludes large domains of "new physics" possibilities, provided their potential contributions to these particular observables do not accidentally cancel. As a consequence of the success of the theory, many conceivable higher-energy experiments are rendered unlikely to provide surprises. An important question is the degree to which one can exclude these novel effects in a sufficiently systematic and rigorous fashion. In this respect, a crucial role is played by certain extremely well-motivated theoretical assumptions. An example is electromagnetic gauge invariance, without which not only would QED self-destroy as a predictive theory, but the study of possible "new physics" would be wildly different. We recall how the analysis of putative QED modifications (characterized by

* Dedicated to Martinus (Tini) Veltman on his 60th $\frac{1}{2}$ birthday.

[1] On leave from Universidad Autónoma de Madrid, Spain.

[2] On leave from Universitat Autónoma de Barcelona, Spain.

From all your UAM group, with love:

Very happy birthday Tini !

... and... we all are waiting for you in a few months