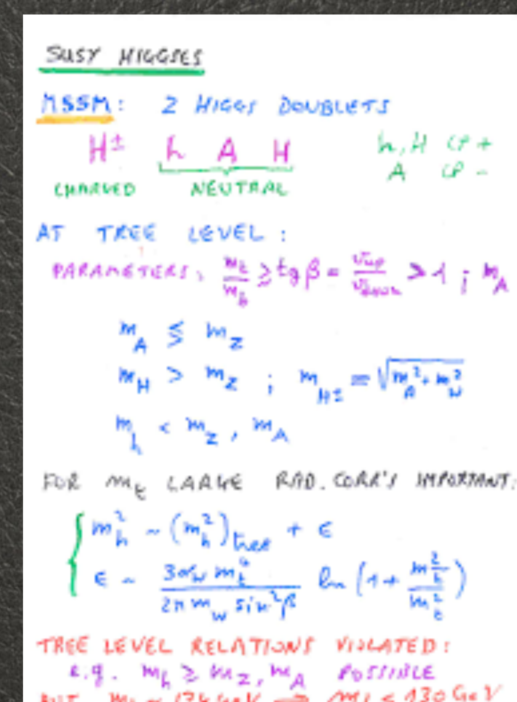
GUIDO ALTARELLI
A MASTER OF PHYSICS



Fernando Ferroni
Sapienza Universita' di Roma & INFN

"I CAN'T WAIT TO FIND OUT WHAT NATURE HAS IN STORE FOR US"

A special colleague, a lot of memories, a lot of physics learned

- I am not the person that can better tell you what Guido has given and left to Science. I am an experimentalist and what I can try to do here is to tell you what I have understood of the importance of Guido's legacy through the impact that his work had on my scientific life.

a coincidence: the November revolution, my laurea thesis, a seminar of Sam Ting at CERN

Is the 3104 MeV Vector Meson the φ_c or the W_0?

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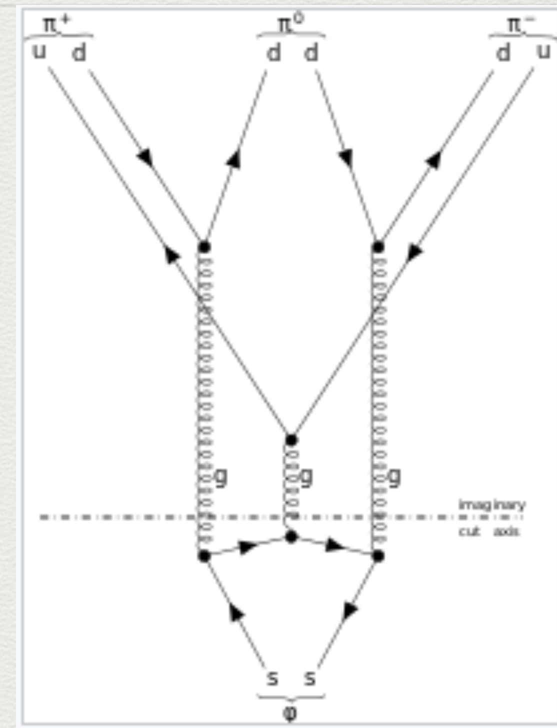
(ricevuto il 20 Novembre 1974)



Process suppressed by the OZI rule

never asked why !

The only expected narrow-width hadronic 1^{-}-particle is the φ_c, *i.e.* a bound state of charmed quarks (4) ($\varphi_c \simeq p'\bar{p}'$).

This identification leads to serious difficulties in that the expected width for φ_c is in the $(1 \div 10)$ MeV range or more, *i.e.* at least a factor of twenty larger than eq. (2).

first …memories from a far past…

- a physics school in former Jugoslavia …on the sea. Good physics but awful food. Guido had a car and suggested to few of the young italian students to move out searching for a restaurant. We ended up after a long search with just mussels …..I leave to your imagination Guido's comments….

a second event

- a physics school somewhere else…a ping pong table…imagine Guido's long arms and a good talent. I eventually won the game …pure satisfaction..and sincere congratulations from him

yet another event..

- Guido director of Roma INFN section (1985-1987). Discussion of request for next year budget. Somebody (I will not name him) explaining with a lot of details the physics of the experiment….and Guido clearly worried by the time schedule saying: look…the physics of the experiment I know better than you , please tell us what you need in term of resources…..

and last ..but without detailed explanation

- laugh to your sister !

for everybody speaking english with a little (!!!!) of roman accent
Guido was a myth

a story that was really fun to listen from Guido

IL NUOVO CIMENTO VOL. XXXIV, N. 5 1° Dicembre 1964

Single Photon Emission in High-Energy e^+-e^- Collisions.

G. ALTARELLI and F. BUCCELLA
Istituto di Fisica Teorica dell'Università - Firenze

(ricevuto il 17 Giugno 1964)

Summary. — In this work we evaluate, for the process $e^+ + e^- \rightarrow e^+ + e^- + \gamma$, the angular distribution of the emitted photons, their energy spectrum, and the total cross-section for the emission of photons of energy $\geqslant \varepsilon$ in the extreme relativistic limit.

as I can tell it has to do with the 'laurea' thesis of both !

Physics finally !

ELSEVIER

Nuclear Physics B

Volume 126, Issue 2, 8 August 1977, Pages 298-318

Asymptotic freedom in parton language

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Received 12 April 1977, Available online 26 October 2002

A novel derivation of the Q 2 dependence of quark and gluon densities (of given helicity) as predicted by quantum chromodynamics is presented. The main body of predictions of the theory for deep-inleastic scattering on either unpolarized or polarized targets is re-obtained by a method which only makes use of the simplest tree diagrams and is entirely phrased in parton language with no reference to the conventional operator formalism.

5891 citations to-date. The most famous ‘french’ physics paper

that paper…and this one

The Physics of Deep Inelastic Phenomena.

G. Altarelli

Istituto di Fisica dell'Università - Roma

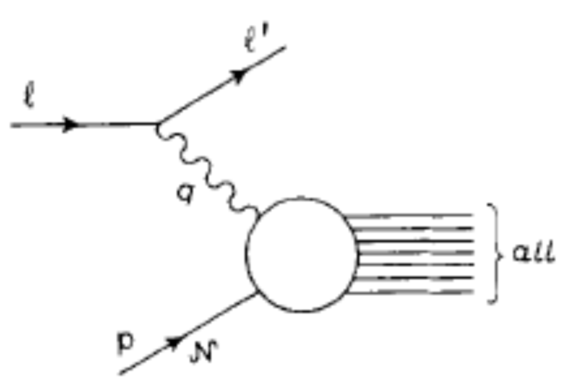
1. – Deep inelastic scattering. Basic formulae and facts.

The kinematics for processes of the form

$$\ell + \mathcal{N} \to \ell' + \text{all}\,, \tag{1.1}$$

where ℓ and ℓ' are leptons, is depicted in Fig. 1. q_μ is the current four-momentum and we define

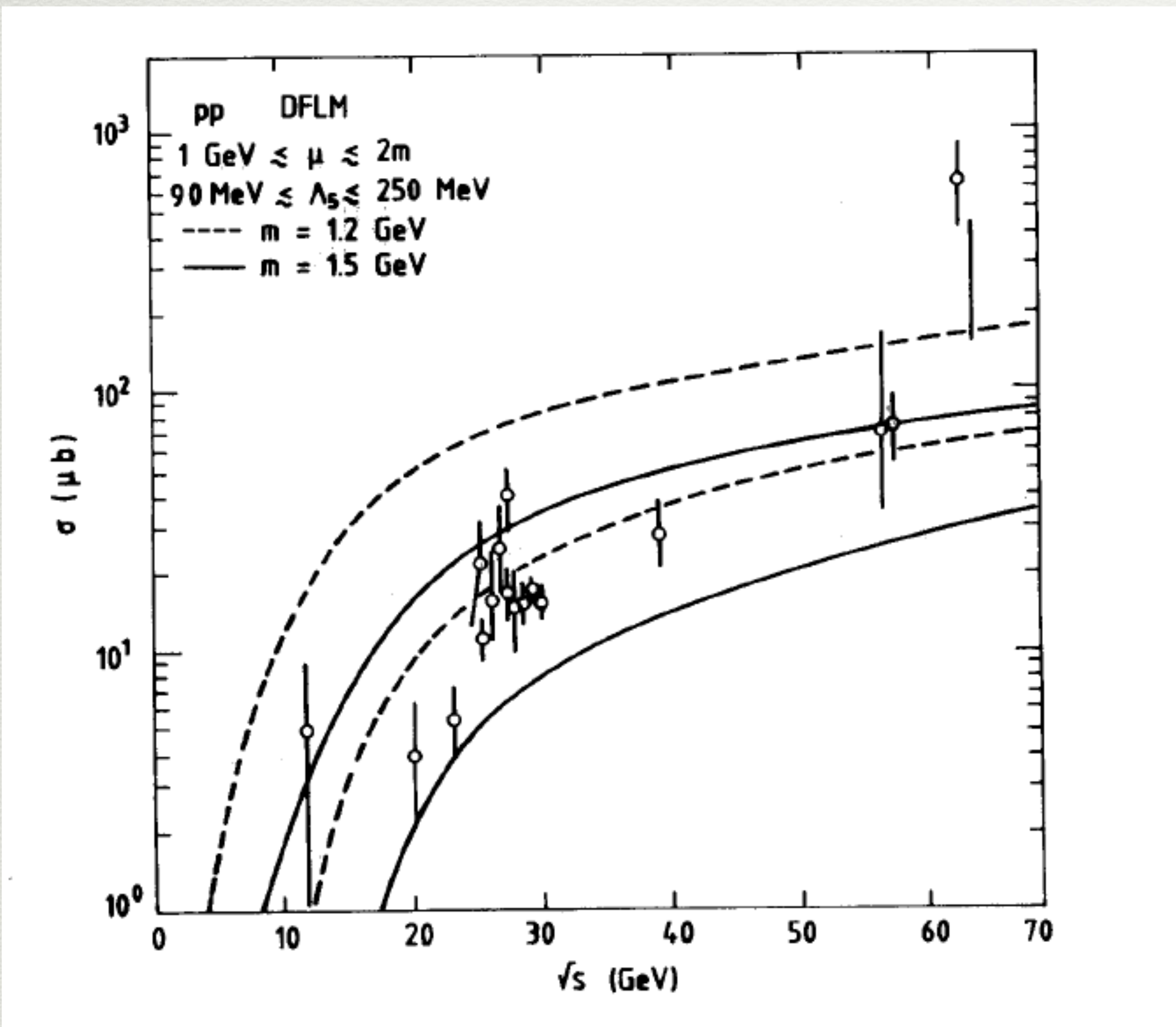
$$\begin{cases} Q^2 = -q^2 = 4EE' \sin^2(\theta/2)\,, \\ m\nu = (p\cdot q)\,, \\ s = (p+q)^2 = -Q^2 + 2m\nu + m^2\,, \\ x = \dfrac{1}{\omega} = \dfrac{Q^2}{2m\nu}\,, \end{cases} \tag{1.2}$$

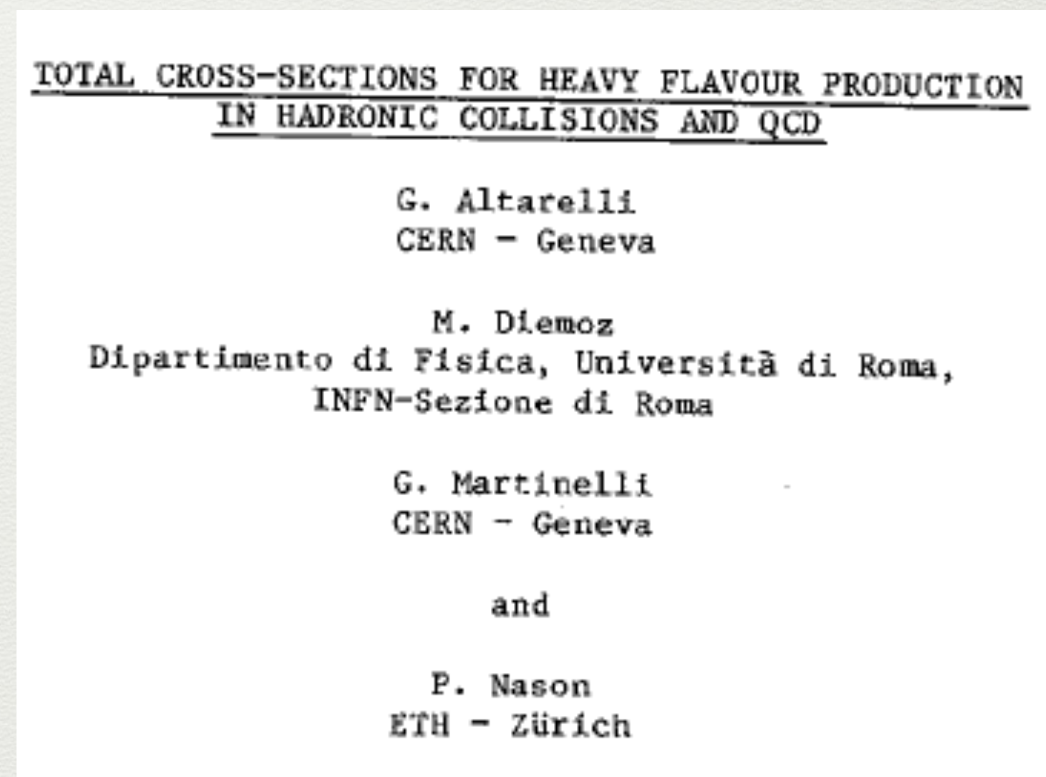


fascinated me so much that when I joined CHARM at CERN it was obvious to me to study the potentiality of neutrinos in terms of measuring the structure functions and the corresponding parton densities

so thanks to Guido we….

- my career got an interesting turn (DiemozFerroniLongoMartinelli)





TOTAL CROSS-SECTIONS FOR HEAVY FLAVOUR PRODUCTION IN HADRONIC COLLISIONS AND QCD

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and

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it was QCD explored with the particle that only interacts weakly

The QCD Running Coupling and its Measurement

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Guido had a passion for alfa strong !

4. Conclusion: My Recommended Value of $\alpha_s(m_Z)$

According to my proposal to calibrate $\alpha_s(m_Z)$ from the theoretically cleanest and most transparent methods, identified as the totally inclusive, light cone operator expansion dominated processes, I collect here my understanding of the results: from Z decays and EW precision tests, eq.(3.3):

$$\alpha_s(m_Z) = 0.1190 \pm 0.0026; \tag{4.1}$$

from scaling violations in DIS, eq.(3.19):

$$\alpha_s(m_Z) = 0.1165 \pm 0.0020; \tag{4.2}$$

from R_τ, eq.(3.10):

$$\alpha_s(m_Z) = 0.1194 \pm 0.0021. \tag{4.3}$$

If one wants to be on the safest side one can take the average of Z decay and DIS:

$$\alpha_s(m_Z) = 0.1174 \pm 0.0016. \tag{4.4}$$

This is my recommended value. If one adds to the average the relatively conservative R_τ value and error given above in eq. 3.10, that takes into account the dangerous low energy scale of the process, one obtains:

$$\alpha_s(m_Z) = 0.1184 \pm 0.0011. \tag{4.5}$$

Note that this is essentially coincident with the "official" average with a moderate increase of the error. Thus we see that a sufficiently precise measure of $\alpha_s(m_Z)$ can be obtained, eqs. (4.4,4.5), by only using the simplest processes where the control of theoretical errors is maximal. One is left free to judge whether a further restriction of theoretical errors is really on solid ground.

The value of Λ (for $n_f = 5$) which corresponds to eq. (4.4) is:

$$\Lambda_5 = 202 \pm 18 \text{ MeV} \tag{4.6}$$

after QCD Guido looks at EW

Future Perspectives in Particle Physics (*).

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(ricevuto il 1 Marzo 1984)

saying clearly (in 1984) what we keep saying now (32 years after)

The standard model is in agreement with essentially all of the experimental information which is very rich by now.

Furthermore, the standard model does not look as the ultimate theory. To a closer inspection a large class of fundamental questions emerges and one finds that a host of crucial problems are left open by the standard model.

(top and Higgs were given for granted)

The next cross

TOWARD A MODEL-INDEPENDENT ANALYSIS OF ELECTROWEAK DATA

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Abstract

We set the framework for a model-independent analysis of the data on electroweak precision tests. Starting from three basic observables, the mass ratio m_W/m_Z, the Z partial width and the forward-backward asymmetry for charged leptons, we define three dimensionless parameters ε_1, ε_2 and ε_3 which contain the small radiative correction effects one is interested in, with large m_t effects only appearing in ε_1. The results on the epsilons implied by the present experimental data are discussed as well as the predictions of the Standard Model, as functions of m_t and m_H, with special attention to evaluating the theoretical errors. We formulate a hierarchy of simple and general assumptions, valid in large classes of models, which are needed in order to relate the epsilons to an increasingly larger set of observables including the τ-polarisation asymmetry, the forward-backward asymmetry for the b-quark, deep inelastic neutrino scattering and atomic parity violation. Correspondingly the analysis of present data is performed in stages and the conclusions are examined at each stage. Finally the case of the Standard Model is recovered as a very relevant particular example.

$$\varepsilon_1 = \Delta\rho = (-0.14 \pm 0.50)\ 10^{-2}$$

$$\varepsilon_2 = (-0.82 \pm 0.93)\ 10^{-2}$$

$$\varepsilon_3 = (-0.39 \pm 0.71)\ 10^{-2}$$

when the illusion was that new physics was there and the only problem was how to better let it show up

very clearly stated

In conclusion, especially in view of the envisaged accuracy that will be obtained by the electroweak tests at the end of the LEP1 phase, the study of the epsilons can provide important constraints and possibly also positive clues on new physics beyond the Standard Model. The isolation of different sectors of the theory, as allowed by the epsilons, may help to clarify the physical origin of any deviation from the Standard Model that will possibly be found or to discard theories that require some specific pattern of radiative effects on the epsilons which turns out to be incompatible with the data.

the moment of disheartenment

THE HIGGS AND THE EXCESSIVE SUCCESS OF THE STANDARD MODEL

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observation

The argument for naturalness is really strong...
except that it has failed so far as a guiding principle

As a consequence:
We can no more be sure that within 3 or 10 or 100 TeV.....
the solution of the hierarchy problem must be found
--> implications for future Colliders

Moreover, it is true that the SM theory is renormalizable
and completely finite and predictive

If you forget the required miraculous fine tuning
you are not punished, you find no catastrophe!!

what then ?

1)Insist on minimizing the fine tuning (FT) within the present experimental constraints.In practice this amounts to imagine suitable forms of new physics at an energy scale as close as possible (with new particles that could hopefully be observable at the LHC14).

2) Accept FT only up to a large intermediate scale (i.e. still far below MGUT): e.g. split SUSY.

3) Make the extreme choice of a total acceptance of FT : the most typical approach being the anthropic philosophy.

4) Argue that possibly there is no FT : make the conjecture that there is no new threshold up to MPl and invoke some miracle within the theory of quantum gravity to solve the naturalness of the EW versus the Planck scale.

this was to show

- one of the many qualities of Guido

Absolute intellectual honesty

never surrender, explore all roads
Neutrinos as new hope

NEUTRINO MASSES: A THEORETICAL INTRODUCTION

1994

Guido Altarelli
CERN – Geneva

Content

a new adventure

STATUS OF NEUTRINO MASS AND MIXING

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In the last two decades experiments have established the existence of neutrino oscillations and most of the related parameters have by now been measured with reasonable accuracy. These results have accomplished a major progress for particle physics and cosmology. At present neutrino physics is a most vital domain of particle physics and cosmology and the existing open questions are of crucial importance. We review the present status of the subject, the main lessons that we have learnt so far and discuss the great challenges that remain in this field.

2014
twenty years later

In conclusion, one could have imagined that neutrinos would bring a decisive boost towards the formulation of a comprehensive understanding of fermion masses and mixings. In reality it is frustrating that no real illumination was sparked on the problem of flavor. We can reproduce in many different ways the observations, in a wide range that goes from anarchy to discrete flavor symmetries but we have not yet been able to single out a unique and convincing baseline for the understanding of fermion masses and mixings. In spite of many interesting ideas and the formulation of many elegant models the mysteries of the flavor structure of the three generations of fermions have not been much unveiled.

a message still valid

Summary

- Higgs, minimal, elementary, standard
- No new physics. Naive naturalness failed

  We expected complexity, we found simplicity
- The SM could hold up to M_{Pl}

  Minimal completions of SM

  Majorana ν's, see-saw, leptogenesis ....
- Today the most crucial problem is Dark Matter

  WIMPS, Axions, keV ν's....
- Different theoretical avenues

  Insist on as minimal as possible Fine Tuning (FT)

  Stealth SUSY, nearby compositeness.....

  Accept some FT

  e.g. Split-SUSY

  Total acceptance of FT: the Anthropic metaphysics
- Denial of FT: the no-threshold philosophy

  the νMSM, scale invariant theories

  price: no GUTs, no heavy ν_R ....

Guido, we sorely miss your:

- integrity
- curiosity
- frankness
- irony
- style
- knowledge

and your talks !