The scientific legacy of Nicola Cabibbo

Dipartimento di Fisica
Sapienza
Università di Roma

Workshop of LHC Higgs Cross Section Working Group 4-5 November 2010

Fernando Ferroni

INFN
Istituto Nazionale di Fisica Nucleare

Nicola Cabibbo

- Let me thanks the organizers for the great honour - and responsability - of commemorating our dear colleague and friend Nicola Cabibbo at this workshop

- I apologize in advance for possible mistakes and inaccuracies due to, me, being a poor experimentalist

Father of Flavor Physics

Nicola Cabibbo

He was the "father of flavor physics" and will be missed. Of course like all great physicists he will live on through the important contributions he has made to our understanding of nature

M. Wise on behalf of the Caltech High Energy Physics

CKM 2006 Nagoya

Nicola Cabibbo, Makoto Kobayashi and (but for one) young italian physicists

personal interlude (1)

- when the Nobel Prize was awarded to KM, one of the young people sent the photo to Nicola by e-mail saying : *'it won't repay you from the frustration but perhaps you might smile at it'*
- Nicola replied *'I am not sad at all. I am happy at looking at how many good things you, that were students of mine, are doing around the world'*

Nagoya CKM 2008

The story of the
hyperons decay
and of a friendship
to last

Universality of Weak Interactions

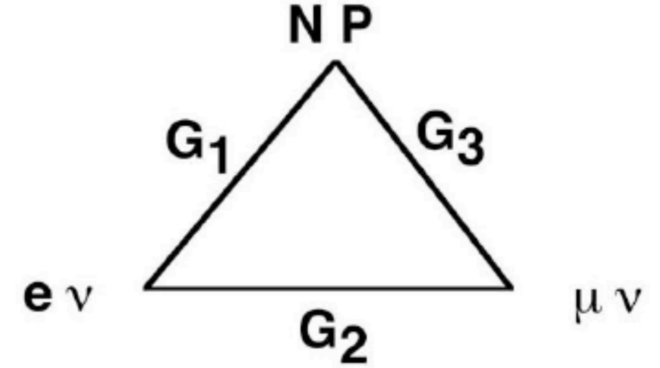
1 - $N \rightarrow P + e + \bar{\nu}$ G_1

2 - $\mu \rightarrow e + \nu + \bar{\nu}$ G_2

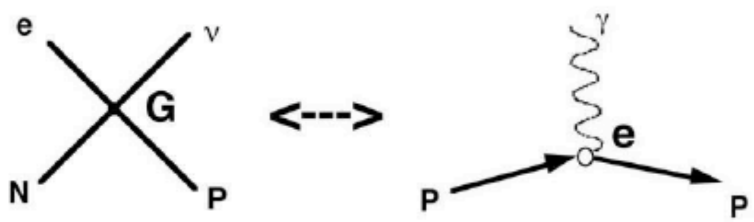
3 - $\mu^- + P \rightarrow N + \nu$ G_3

In ~ 1950 $G_1 \approx G_2 \approx G_3$

The Puppi Triangle



Suggestive in view of Fermi's idea:



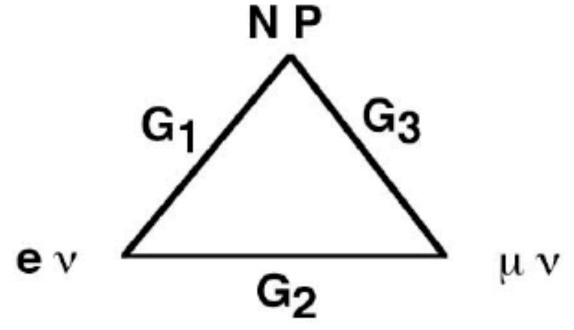
Universality of Weak Interactions 1962-63

$G_1 \approx G_2 \approx G_3$

Suggestive, but true?

$G_{\text{beta decay}} \approx 0.96 \; G_{\mu \text{ decay}}$

(Significative Difference)



$4 - \Lambda \to P + e + \bar{\nu} \qquad G_4$

And for strange particle decays....

$G_4 \approx 0.2 \; G_{\text{m decay}}$

Universality of Weak Interactions 1962-63

Towards a solution:

1) Gell-Mann's SU(3) symmetry and its application to weak transitions.
(N.C. + R. Gatto 1962)

2) High statistics (for that time) bubble chamber experiments.
(V. Soergel, Filthut, P. Franzini, G. Snow, etc.)

N **P**

Σ^- Σ^0, Λ Σ^+

Ξ^- Ξ^0

Universality and weak mixing

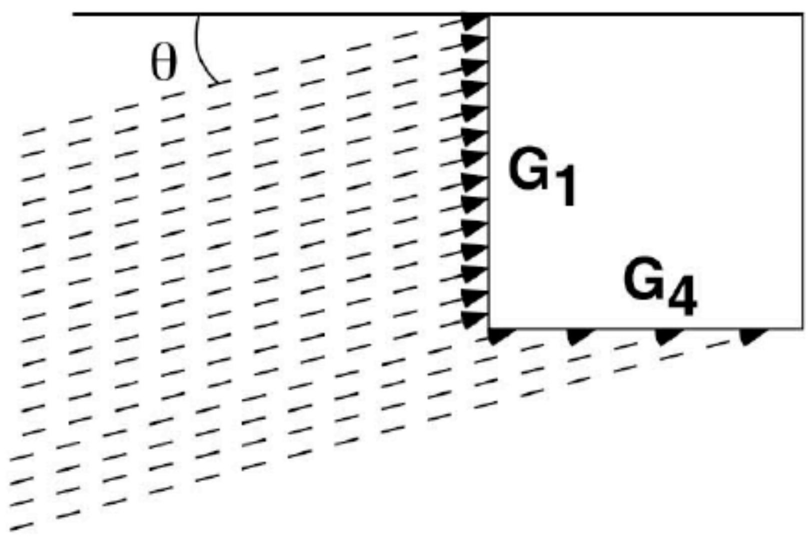
$N \to P + e^- + \nu \quad G_1 \approx 0.96\, G_{\mu\text{-decay}}$

$\Lambda \to P + e^- + \nu \quad G_4 \approx 0.2\, G_{\mu\text{-decay}}$

Broken Universality?
<u>no</u>, shared intensity

$G_1 = \cos\theta\, G_{\mu\text{-decay}}$

$G_4 = \sin\theta\, G_{\mu\text{-decay}}$



$\theta \approx 0.2$ (today 0.221)

A close friendship with P. Franzini (see later !)

TEST OF THE CONSERVED VECTOR CURRENT HYPOTHESIS IN $\Sigma^{\pm} \rightarrow \Lambda^{0}$ LEPTONIC DECAYS

N. CABIBBO and P. FRANZINI *
CERN, Geneva

Received 13 December 1962

It has been proposed [1,2] that the decay processes

$$\Sigma^{-} \rightarrow \Lambda^{0} + e^{-} + \bar{\nu}\,, \quad (1a)$$

$$\Sigma^{+} \rightarrow \Lambda^{0} + e^{+} + \nu \quad (1b)$$

could provide a test of the conserved vector current hypothesis [3].

In the present work we show how such a test can be performed through the combined measurement of the branching ratio for the above decays, the average Λ^{0} polarisation from unpolarised Σ's ** and the Λ^{0} hyperon spectrum. The matrix element for process (1a) can be written as

$$2\pi i G\left(\bar{e}\gamma_{\mu}\frac{1+\gamma_5}{2}\nu\right)\langle\Lambda^{0}|J_{\mu}^{A}(0)+J_{\mu}^{V}(0)|\Sigma^{-}\rangle \times \delta^{4}(p_{\Sigma}-p_{\Lambda}-p_{\nu}-p_{e})\,, \quad (2)$$

where G is the Fermi coupling constant, J^{A} and J^{V} the strangeness conserving axial and vector currents. From Lorentz invariance we can express the matrix elements of J^{V} and J^{A} in terms of six form factors; for the case of even $\Sigma\Lambda$ parity we have

$$(2\pi)^3\langle\Lambda^{0}|J_{\mu}^{V}|\Sigma^{-}\rangle = \bar{u}^{\Lambda^{0}}[a(q^2)\gamma_{\mu} + b(q^2)\sigma_{\mu\nu}q_{\nu} + b'(q^2)q_{\mu}]\,u^{\Sigma^{-}}\,, \quad (3)$$

$$(2\pi)^3\langle\Lambda^{0}|J_{\mu}^{A}|\Sigma^{-}\rangle = \bar{u}^{\Lambda^{0}}[c(q^2)\gamma_{\mu}\gamma_5 + d(q^2)\sigma_{\mu\nu}q_{\nu}\gamma_5 + d'(q^2)q_{\mu}\gamma_5]\,u^{\Sigma^{-}}\,, \quad (4)$$

$$q_{\mu} = p_{e}^{\mu} + p_{\bar{\nu}}^{\mu}\,.$$

It is convenient to classify contributions according to forbiddenness: the terms with γ_{μ} and $\gamma_{\mu}\gamma_5$ give allowed contributions if $a(0)$ and respectively $c(0)$ are different from zero. The other terms give at most first forbidden contributions †. Terms with b' and d' being of the order of M_e/M_{Λ^0} will be neglected in the following.

Under the conserved vector current hypothesis one finds [1] that

$$a(0) = 0\,, \quad (5)$$

* On leave of absence from Università di Pisa and Istituto Nazionale di Fisica Nucleare, Sezione di Pisa, Pisa, Italy.

** Or through the measurement of the asymmetry of Λ^{0}'s from polarised Σ hyperons.

† The classification in terms of forbiddenness corresponds he… tude in p…

Nicola, why don't you do something fundamental!

SIGMA LEPTONIC DECAYS AND CABIBBO'S THEORY OF LEPTONIC DECAY*

W. Willis†
Brookhaven National Laboratory, Upton, New York

and

H. Courant,‡ H. Filthuth,§ P. Franzini,‖ A. Minguzzi-Ranzi,** and A. Segar††
CERN, Geneva, Switzerland

and

R. Engelmann, V. Hepp, and E. Kluge
University of Heidelburg, Heidelburg, Germany

and

R. A. Burnstein, T. B. Day, R. G. Glasser,‡‡ A. J. Herz, B. Kehoe, B. Sechi-Zorn, N. Seeman, and G. A. Snow§§
University of Maryland, College Park, Maryland and U. S. Naval Research Laboratory, Washington, D. C.

(Received 17 July 1964)

UNITARY SYMMETRY AND LEPTONIC DECAYS

Nicola Cabibbo
CERN, Geneva, Switzerland
(Received 29 April 1963)

We present here an analysis of leptonic decays based on the unitary symmetry for strong interactions, in the version known as "eightfold way,"[1] and the V-A theory for weak interactions.[2,3] Our basic assumptions on J_μ, the weak current of strong interacting particles, are as follows:

(1) J_μ transforms according to the eightfold representation of SU_3. This means that we neglect currents with $\Delta S = -\Delta Q$, or $\Delta I = 3/2$, which should belong to other representations. This limits the scope of the analysis, and we are not able to treat the complex of K^0 leptonic decays, or $\Sigma^+ \rightarrow n + e^+ + \nu$ in which $\Delta S = -\Delta Q$ currents play a role. For the other processes we make the hypothesis that the main contributions come from that part of J_μ which is in the eightfold representation.

(2) The vector part of J_μ is in the same octet as the electromagnetic current. The vector contribution can then be deduced from the electromagnetic properties of strong interacting particles. For $\Delta S = 0$, this assumption is equivalent to vector-

Unitary Symmetry and Leptonic Decays.
Nicola Cabibbo (CERN). Jun 1963. 3 pp.
Published in **Phys.Rev.Lett. 10 (1963) 531-533**

References | BibTeX | LaTeX(US) | LaTeX(EU) | EndNote
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A beautiful mind

The son of a sicilian lawyer, Nicola Cabibbo, born in Roma on April 10, 1935, lived his childhood during the second world war. During these difficult years, Nicola discovered astronomy and developed a strong interest in the construction of radio devices. This was the starting point of a life-long interest and an extraordinary skill in the realization of hardware, including the mirror of a telescope and a home made personal computer - the first of a series - at the beginning of the `80.

These passions and a book entitled ``Che cos'e` la matematica" pushed him to follow scientific studies. After the war, he also developed a passion for american literature, passion shared by his wife who is presently professor of american literature at the University La Sapienza.

Another great passion was the sea and sailing: at the end of the `70 he constructed a sailing boat by himself (indeed he bought the boat ``shell" and made the rest).

The beginning

- He graduated in theoretical physics at Universita' di Roma "La Sapienza" , with a thesis on weak interactions and muon decays, under the supervision of Bruno Touschek, whom he always considered his mentor. He was immediately tenured and in 1960 moved to Frascati, where at the beginning of the sixties, Touschek and collaborators were building the first electron-positron collider.

personal interlude (2)

- I was in Erice as a very young student

1977	INTERNATIONAL SCHOOL OF SUBNUCLEAR PHYSICS - Director: A. ZICHICHI 15th Course: *The Whys of Subnuclear Physics* 23 July - 10 August 1977	

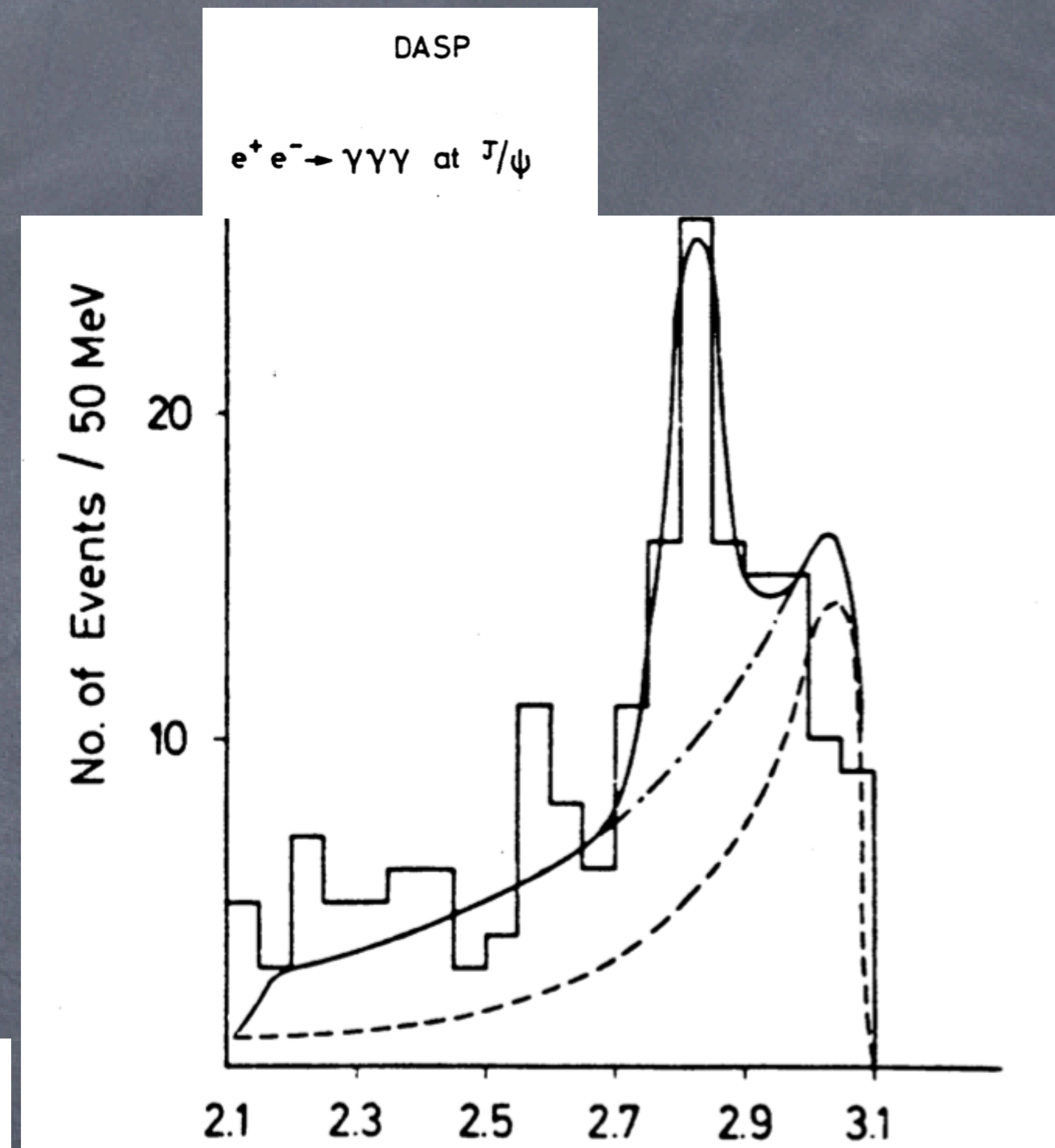
- Nicola was of course giving a talk but this is not the point....

- H. Schopper was also giving one

The Properties of Charmonium and Charm Particles.
Herwig Schopper (DESY & Hamburg U.). DESY-77-79. Dec 1977. 127 pp.
Published in **Subnucl.Ser. 15 (1979) 203-355**

about the discovery of η_c

I remember vividly Nicola arguing on experimental detail against that.
It turns that:



(2.83 ± 0.03) GeV/c^2

$\eta_c(1S)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass $m = 2980.3 \pm 1.2$ MeV (S = 1.6)
Full width $\Gamma = 28.6 \pm 2.2$ MeV (S = 2.0)

back to e^+e^-

- With Raoul Gatto, the young Cabibbo wrote an exploratory paper on the physics that could be studied with e+ e- interactions, a paper that soon became a standard reference in the field. His collegues were used to call this paper ``the Bible" since it contained the calculation of all the cross sections for processes then envisageable.

Electron Positron Colliding Beam Experiments.
N. Cabibbo, Raoul Gatto (Rome U. & Cagliari U. & Frascati). Dec 1961. 19 pp.
Published in **Phys.Rev. 124 (1961) 1577-1595**

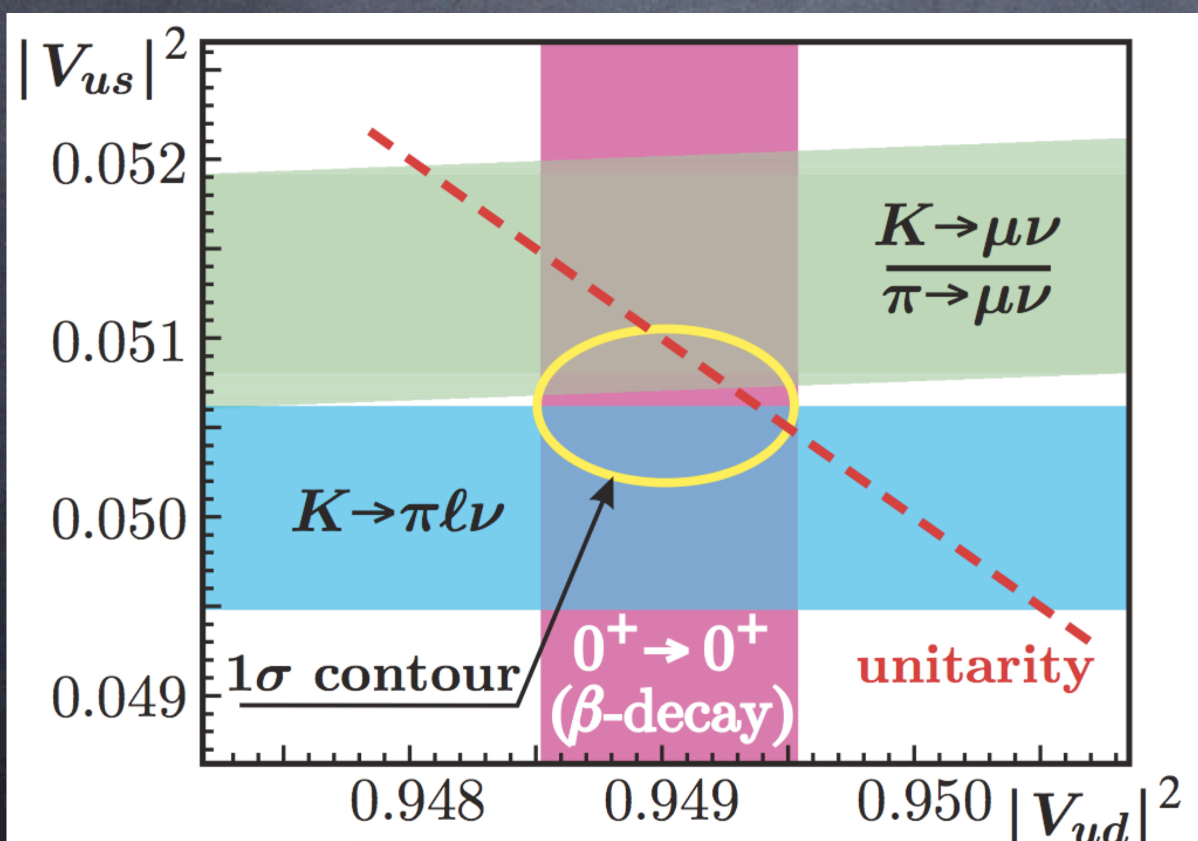
remarkable words

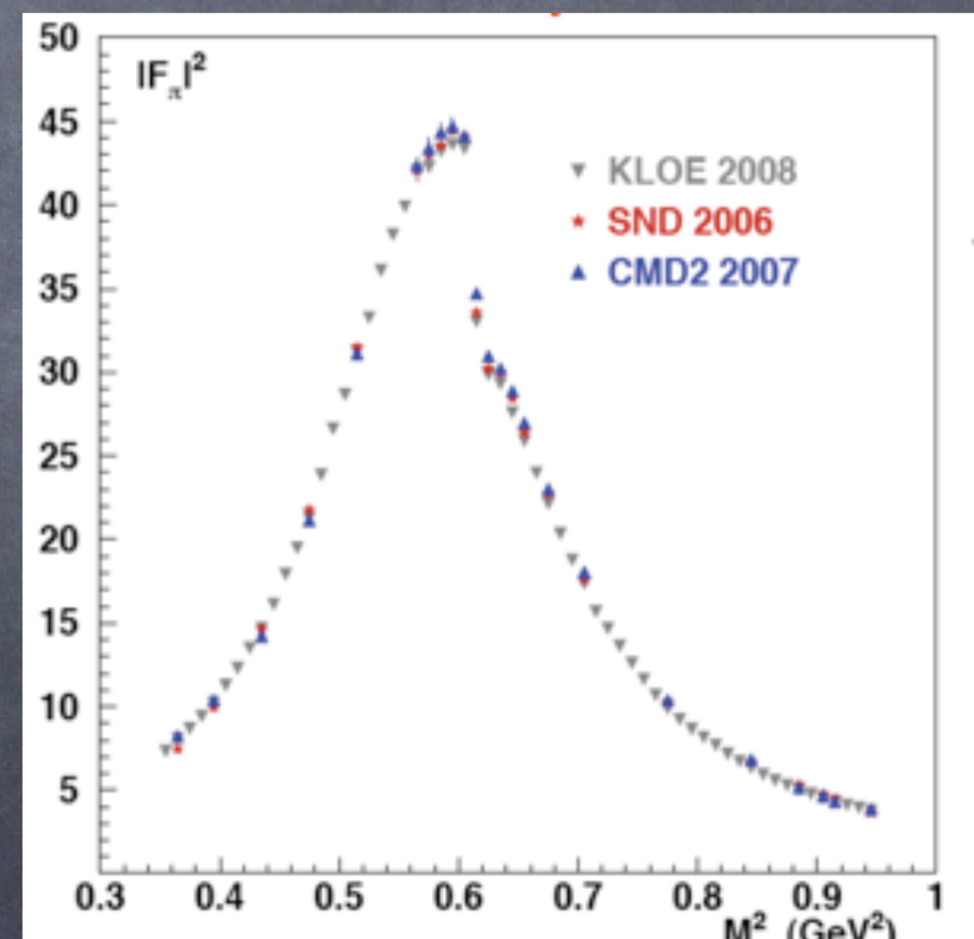
Vector bosons have also been suggested as intermediary agents of weak interactions.[28] Their production in pairs in electron-positron annihilation would be a convenient test for their existence. Neutral intermediary vector bosons can only be coupled to neutral lepton pairs provided they do not couple to the weak strangeness-nonconserving currents. If they existed and were coupled to leptons they would produce an evident resonance-like behavior in annihilation reactions. Par-

Back to the future

P. Franzini
back from USA
spokeperson

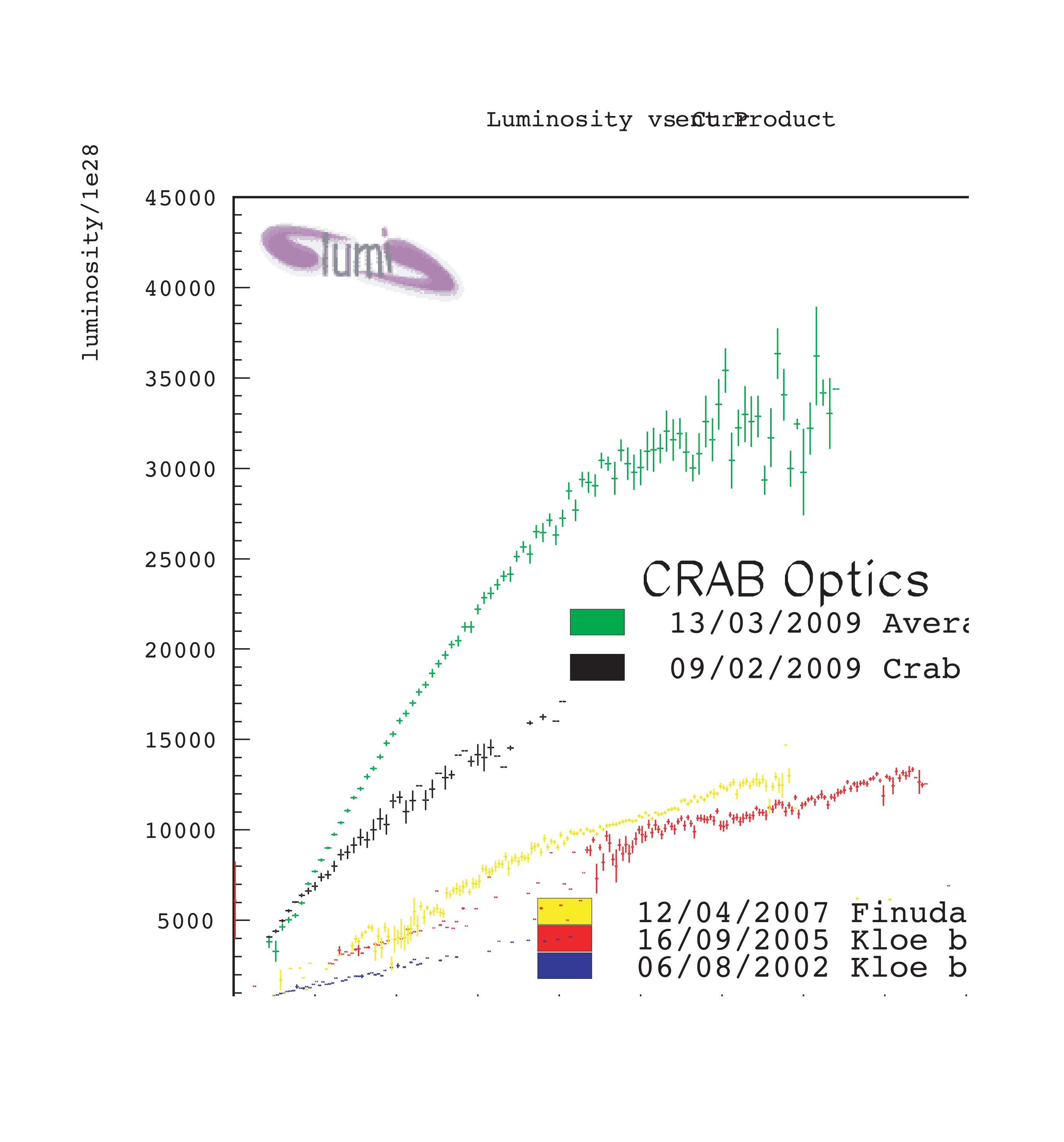
Nel 1990 l'INFN, sotto la presidenza di Nicola Cabibbo, diede approvazione ufficiale per la costruzione del nuovo collisore, battezzato DAΦNE, una fabbrica di ϕ



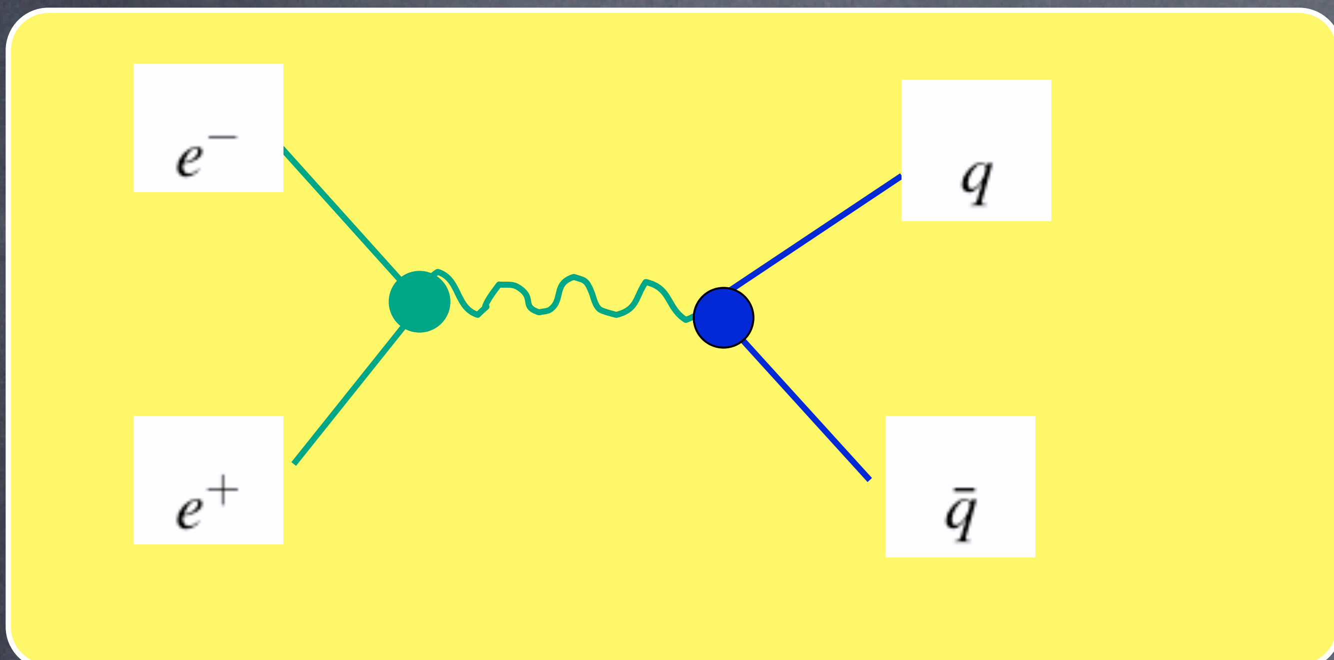


$$a_\mu(\text{had}) = \left(\frac{\alpha m_\mu}{3\pi}\right)^2 \int_{4m_\pi^2}^{\infty} \frac{ds}{s^2} K(s) \left(\frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma(e^+e^- \to \mu^+\mu^-)}\right)$$

Dafne as a prototype for future accelerators



More on e^+e^-



$$R_{e^+e^-}(S) = \frac{\sigma(e^+e^- \to hadrons)}{\sigma(e^+e^- \to \mu^+\mu^-)}$$

LETTERE AL NUOVO CIMENTO VOL. IV, N. 1 4 Luglio 1970

Hadron Production in e^+e^- Collisions (*).

N. Cabibbo

Istituto di Fisica dell'Università - Roma
Istituto Nazionale di Fisica Nucleare - Sezione di Roma

G. Parisi and M. Testa

Istituto di Fisica dell'Università - Roma

(ricevuto il 30 Maggio 1970)

1. – The simple properties of deep inelastic electron-proton scattering has suggested models where these processes arise as interactions of virtual photons with an « elementary » component of the proton. These as yet unspecified elementary components of the proton have been given the name of « partons » by Feynman (1). The model has been studied by Bjorken and Paschos (2) and successively by Drell, Levy and Tung Mow Yan (3) who gave a field-theoretical treatment of the parton model, and were able to recover some of the experimentally observed properties of this process. In this letter we wish to extend the method of ref. (3) to the study of the total cross-section of electron-positron annihilation into hadrons.

This treatment leads to an asymptotic (very high cross-section c.m. energy, $2E$) of the form

$$\sigma \to \frac{\pi\alpha^2}{12E^2}\left[\sum_{\text{spin } 0}(Q_i)^2 + 4\sum_{\text{spin } \frac{1}{2}}(Q_i)^2\right], \tag{1}$$

where Q_i *is the* charge of the i-th parton in units of e. This is simply the sum of the contributions of the single partons considered as pointlike (4). Each parton contributes a different kind of events to the total cross-section. The typical high-energy event should consist in the production of a pair of virtual partons, each of which develops into a jet of physical hadrons.

(*) This research has been sponsored in part by the Air Force Office of Scientific Research, through the European Office of Aerospace Research OAR, United States Air Force, under contract f 61 05267 C 0084.

(1) R. P. Feynman: unpublished.

(2) J. D. Bjorken and E. A. Paschos: *Phys. Rev.*, **185**, 1976 (1969).

(3) S. D. Drell, D. J. Levy and Tung Mow Yan: *Phys. Rev. Lett.*, **22**, 744 (1969); *Phys. Rev.*, **187**, 2159 (1969).

(4) Equation (1) extends the well-known result obtained by J. D. Bjorken: *Phys. Rev.*, **148**, 1467 (1966) in the case of spin-½ partons.

on asymptotic freedom

Volume 59B, number 1 PHYSICS LETTERS 13 October 1975

EXPONENTIAL HADRONIC SPECTRUM AND QUARK LIBERATION

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Istituto Nazionale di Fisica Nucleare, Sezione di Rome, Italy

G. PARISI
Istituto Nazionale di Fisica Nucleare, Frascati, Italy

Received 9 June 1975

The exponentially increasing spectrum proposed by Hagedorn is not necessarily connected with a limiting temperature, but it is present in any system which undergoes a second order phase transition. We suggest that the "observed" exponential spectrum is connected to the existence of a different phase of the vacuum in which quarks are not confined.

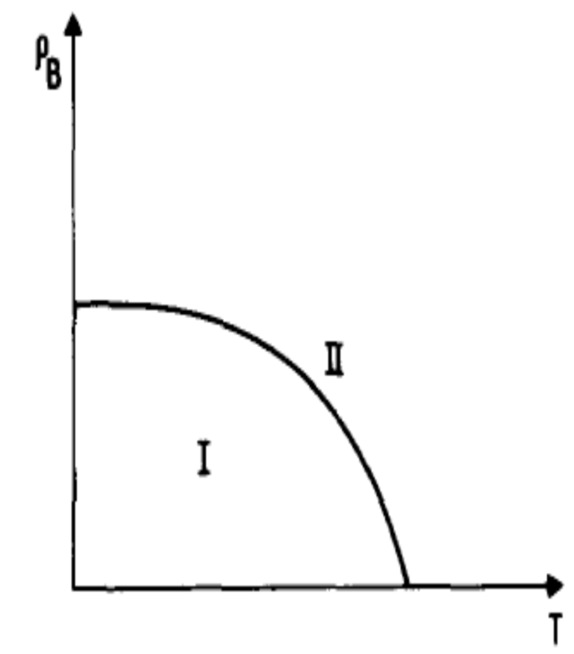

Fig. 1. Schematic phase diagram of hadronic matter. ρ_B is the density of baryonic number. Quarks are confined in phase I and unconfined in phase II.

a mind exploring different possibilities

Volume 119B, number 4,5,6 PHYSICS LETTERS 23/30 December 1982

A NEW METHOD FOR UPDATING SU(N) MATRICES IN COMPUTER SIMULATIONS OF GAUGE THEORIES

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and

Enzo MARINARI
Istituto di Fisica "G. Marconi", Università di Roma, Rome, Italy
and INFN, Sezione di Roma, Rome, Italy

Received 12 July 1982

We present a new method for updating SU(N) matrices in lattice gauge theories simulations. The new method has been found for the case of SU(3) to be about three times more efficient than the Metropolis method.

In this paper we propose a new method for updating SU(N) matrices which is a natural extension of the Creutz method for SU(2).

Tests executed on a 4^4 lattice in SU(3) indicate that the method is more efficient that the Metropolis method: the new method led to a 40% saving in the computer time used for one iteration, and the thermalization is achieved faster, as indicated by a flatter hysteresis cycle during fast thermal excursions.

Opening the way to lattice calculations

Ref.TH.3774-CERN
INFN-375
Sezione di Roma

WEAK INTERACTIONS ON THE LATTICE

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INFN, Sezione di Roma, Roma, Italy

G. Martinelli

INFN, Laboratori Nazionali di Frascati,
Frascati, Italy

and

R. Petronzio *)

CERN -- Geneva

ABSTRACT

We show that lattice QCD can be used to evaluate the matrix elements of four fermion operators which are relevant for weak decays. A first comparison between the results obtained on the lattice and other determinations is also presented.

*) On leave from Dipartimento di Fisica, Università di Roma "La Sapienza", and INFN, Sezione di Roma, Roma, Italy.

a long and succesful road

but you need a powerful and dedicated computer

APE: **A High Performance Processor for Lattice QCD.**
N. Cabibbo, . Oct 1984. 8pp.
IN *PISA 1984, PROCEEDINGS, OLD AND NEW PROBLEMS IN FUNDAMENTAL PHYSICS* 137-144.

The APE Computer: An Array Processor optimized for Lattice Gauge Theory Simulations.

The APE collaboration

M. Albanese[4], P. Bacilieri[1], S. Cabasino[2], N. Cabibbo[3], F. Costantini[4], G. Fiorentini[4], F. Flore[4], L. Fonti[1], A. Fucci[5], M. P. Lombardo[4], S. Galeotti[4], P. Giacomelli[8], P. Marchesini[5], E. Marinari[3], F. Marzano[2], A. Miotto[6], P. Paolucci[2], G. Parisi[3], D. Pascoli[6], D. Passuello[4], S. Petrarca[2], F. Rapuano[2], E. Remiddi[1,7], R. Rusack[8], G. Salina[2], R. Tripiccione[4].

Abstract

The APE computer is a high performance processor designed to provide massive computational power for intrinsically parallel and omogeneous applications. APE is a linear array of processing elements and memory boards that execute in parallel in SIMD mode under the control of a CERN/SLAC 3081/E. Processing elements and memory boards are connected by a 'circular' switchnet. The hardware and software architecture of APE, as well as its implementation are discussed in this paper. Some physics results obtained in the simulation of lattice gauge theories are also presented.

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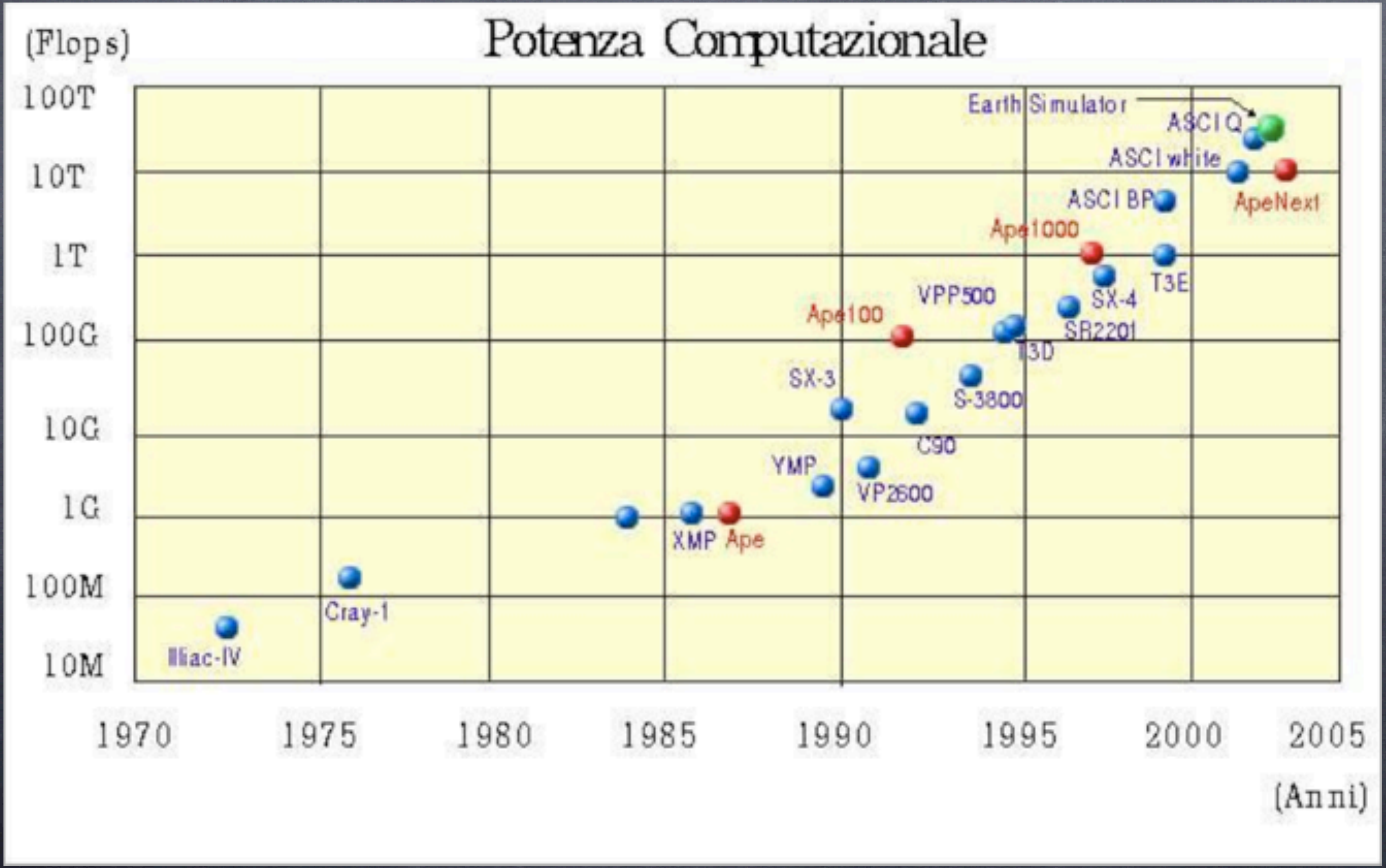
1) INFN-CNAF, Bologna. 2) Dipartimento di Fisica, I Universita' di Roma "La Sapienza" and INFN-Sez. di Roma. 3) Dipartimento di Fisica, II Universita' di Roma "Tor Vergata" and INFN-Sez. di Roma. 4) Dipartimento di Fisica, Universita' di Pisa and INFN-Sez. di Pisa. 5) CERN, Geneva, Switzerland. 6) Dipartimento di Fisica, Universita' di Padova and INFN-Sez. di Padova. 7) Dipartimento di Fisica, Universita' di Bologna and INFN, Sez. di Bologna. 8) The Rockefeller University, New York.

APE at the bleeding edge of computing



February 2006 Inauguration of the APENEXT LAB (INFN-La Sapienza)

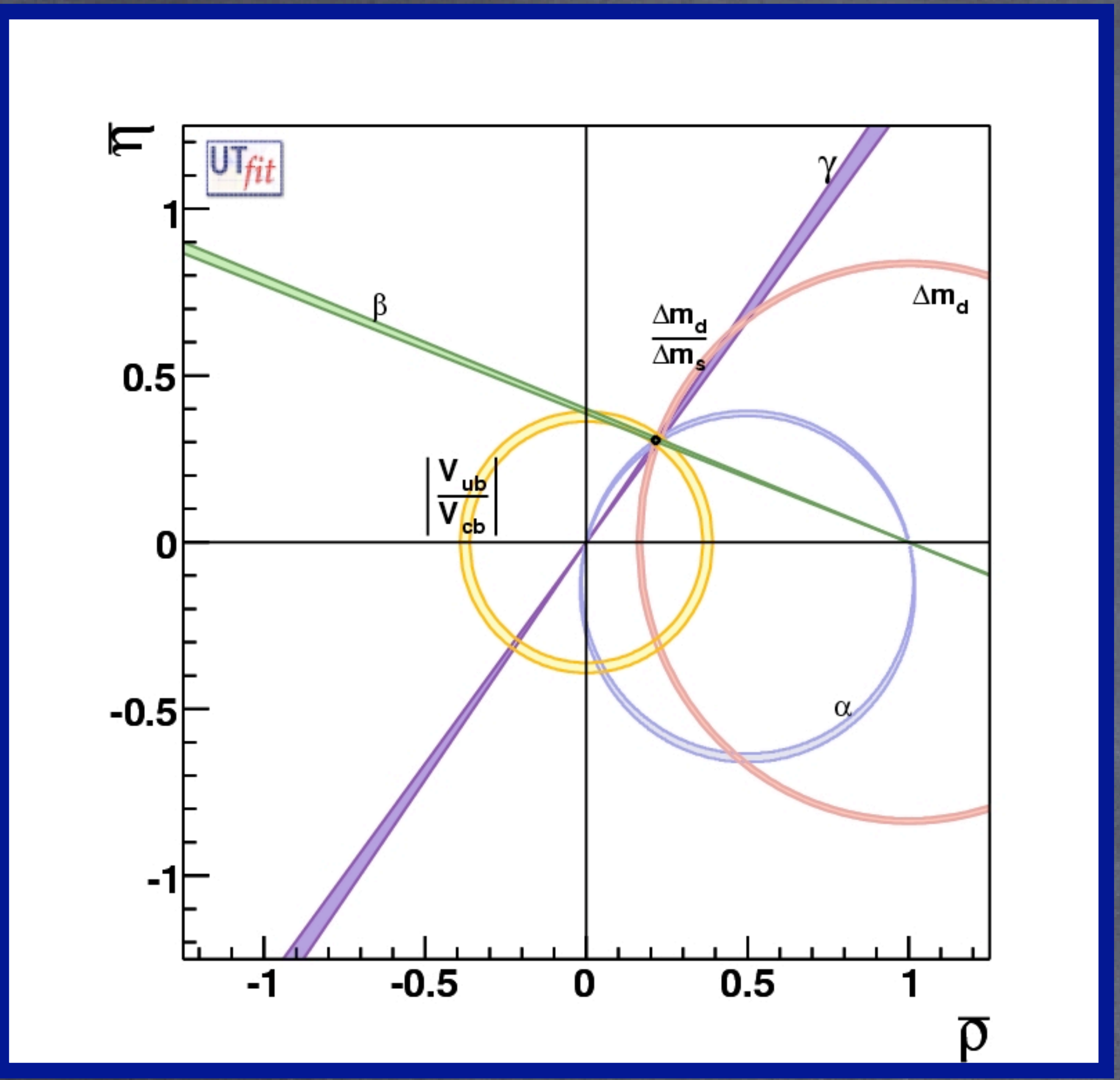
APE Impact

- Scientific, technological and social impacts:
  - APE is standard "de facto" in European LQCD computing area
  - Huge number of scientific and technological (HW, SW, Architecture) papers
  - Establishment of an international computing facility fully dedicated to scientific numerical computing
    - Laboratorio di Calcolo apeNEXT: 12 TFs installed, opening on February, 8th
  - Strategic opportunities to increase national(European) industry capability
    - Eurotech
      - INFN collaboration -> HPC division, market expansion, international visibility
    - Finmeccanica/QSW
  - Training, dissemination and establishment of spin-off companies
    - Atmel/Ipitec
    - Nergal
    - Digital Video
    - Venere

SPIN OFF OF THE APE PROJECT

Cabibbo as smart manager
as INFN and ENEA President

a long way since



Estimates of error for 2015

Hadronic matrix element	Current lattice error	6 TFlop Year	60 TFlop Year	1-10 PFlop Year
$f_+^{K\pi}(0)$	0.9% (22% on 1-f_+)	0.7% (17% on 1-f_+)	0.4% (10% on 1-f_+)	**< 0.1% (2.4% on 1-f_+)**
$\hat{B}_K$	11%	5%	3%	**1%**
f_B	14%	3.5 - 4.5%	2.5 - 4.0%	**1 – 1.5%**
$f_{Bs}B_{Bs}^{1/2}$	13%	4 - 5%	3 - 4%	**1 – 1.5%**
ξ	5% (26% on ξ-1)	3% (18% on ξ-1)	1.5 - 2 % (9-12% on ξ-1)	**0.5 – 0.8 % (3-4% on ξ-1)**
$\mathcal{F}_{B\to D/D^*l\nu}$	4% (40% on 1-$\mathcal{F}$)	2% (21% on 1-$\mathcal{F}$)	1.2% (13% on 1-$\mathcal{F}$)	**0.5% (5% on 1-$\mathcal{F}$)**
$f_+^{B\pi}$,...	11%	5.5 - 6.5%	4 - 5%	**2 – 3%**
$T_1^{B\to K^*/\rho}$	13%	----	----	**3 – 4%**

something familiar to you here

Ref.TH.2683-CERN

BOUNDS ON THE FERMIONS AND HIGGS BOSON MASSES IN GRAND UNIFIED THEORIES

N. Cabibbo
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INFN - Sezione di Roma

L. Maiani
CERN - Geneva

G. Parisi
INFN - Laboratori Nazionali di Frascati

and

R. Petronzio
CERN - Geneva

A B S T R A C T

In the framework of grand unifying theories the requirement that no interaction becomes strong and no vacuum instability develops up to the unification energy, is shown to imply upper bounds to the fermion masses as well as upper and lower bounds to the Higgs boson mass. These bounds are studied in detail for the case of the unifying groups SU(5) or O(10).

Ref.TH.2683-CERN
12 June 1979

A similar analysis can be applied to Eq. (3.5). The bound on $\lambda(\eta^2)$ for different values of $h^2(\eta^2)$ can be found, by solving numerically Eq. (3.5) and requiring $\lambda(q^2)$ to be finite for $q^2 < M_U^2$. The bound on $\lambda(\eta^2)$ thus found gives a bound on the Higgs boson mass, according to :

$$M_H^2 = \frac{2}{3}\lambda(\eta^2)\cdot\eta^2$$

Upper limits

The resulting bound on M_H, as a function of the heavy quark mass, is shown in Fig. 1, for the case $N=3$, and in Fig. 2, for the case $N=8$.

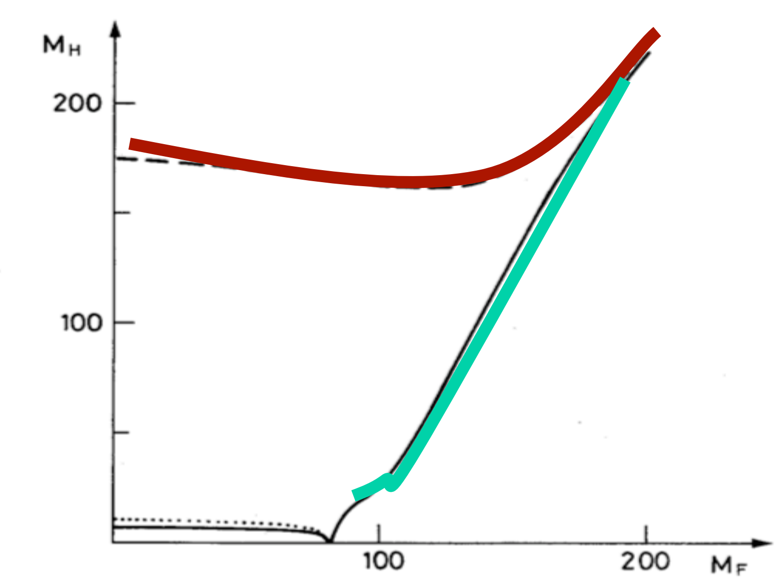

FIG. 1

Lower limits given by the stability of the potential

Cabibbo experimentalist

Determination of the $a_0 - a_2$ pion scattering length from $K^+ \to \pi^+\pi^0\pi^0$ decay

Nicola Cabibbo[1, 2]

CERN, Physics Department
CH-1211 Geneva 23, Switzerland

Abstract

We present a new method for the determination of the $\pi - \pi$ scattering length combination $a_0 - a_2$, based on the study of the $\pi^0\pi^0$ spectrum in $K^+ \to \pi^+\pi^0\pi^0$ in the vicinity of the $\pi^+\pi^-$ threshold. The method requires a minimum of theoretical input, and is potentially very accurate.

hep-ph/0502130v1 14 Feb 2005

Pion-pion scattering and the $K \to 3\pi$ decay amplitudes

Nicola Cabibbo[a,b] and Gino Isidori[c]

[a] CERN, Physics Department, CH-1211 Geneva 23, Switzerland

[b] Dipartimento di Fisica Università di Roma "La Sapienza" and INFN, Sezione di Roma, P.le A. Moro 2, I-00185 Rome, Italy

[c] INFN, Laboratori Nazionali di Frascati, I-00044 Frascati, Italy

arXiv:1004.1005v1 [hep-ex] 7 Apr 2010

Empirical parameterization of the $K^\pm \to \pi^\pm\pi^0\pi^0$ decay Dalitz plot

The NA48/2 Collaboration

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and looking forward

Proposal to measure the rare decay K+ ---> pi+ nu anti-nu at the CERN SPS.
G. Anelli *et al.* CERN-SPSC-2005-013, CERN-SPSC-P-326, Jun 2005. 93pp.

SEZIONE	NOME COGNOME	TIPO	RICERCATORI	TECNOLOGI	TOT. PERS.	FTE	FTE / PERS.
RM1	Cabibbo Nicola	assoc	Prof. Ordinario			40	
	D'agostini Giulio	assoc	Prof. Associato			80	
	Leonardi Emanuele	dip		Tecnologo		100	
	Serra Marco	dip		Tecnologo		50	
	Valente Paolo	dip	Ricercatore			80	
RM1			**2 fte 3 pers.**	**1.5 fte 2 pers.**	**5**	**3.5**	**0.700**

Nicola in the book of CSN1

A beloved teacher

- Nicola was keen to teach and continued to do it until very recently.

He was able to find simple arguments, and arrive to classical results with original and intuitive demonstrations, to explain difficult concepts.

His students were fascinated by his simplicity, gentle modes and sense of humour. So we did, all of us we who had the privilege to be his collaborators and friends. (L. Maiani)

and the students

Ciao Nicola

In all circumstances, Nicola has shown an extreme courtesy and kindness to anybody, refusing, for example, any controversy for the missing/missed Nobel prize.
With the same precious style, he has accomplished his obligations as President of INFN, first, President of ENEA and President of the Pontificial Academy of Sciences.
Nicola was able to combine an extraordinary physics insight, vision with management skill and integrity.
He will remain a reference for those who had the privilege to interact with him, and for the future generations of young researchers who will share with him the passion for physics and in general the love for the investigation of the misteries of Nature.

We are all grateful to him and we shall sorely miss him.

(G. Martinelli)