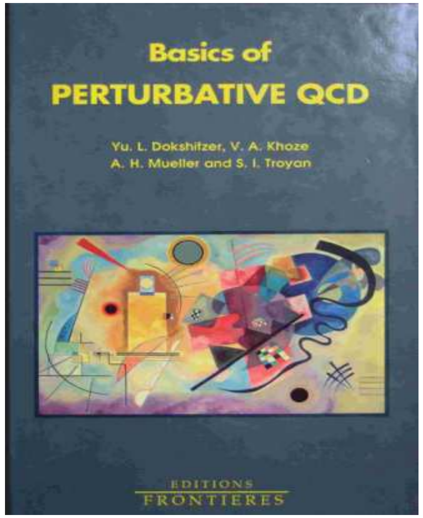
Yuri65Fest

Paris, 18th November, 2016



HE HAS A PICTURE

(25 years of collaboration -1980-2006,
45 joint publications)

V.A. Khoze (IPPP, Durham and PNPI)

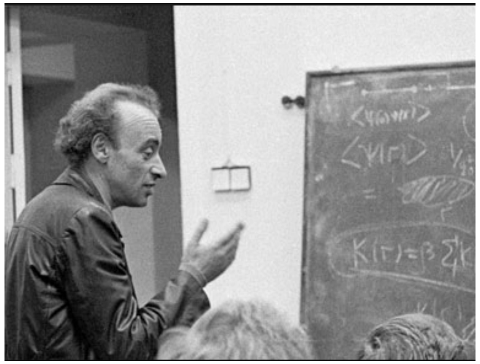
Selected topics from our joint papers with Yuri (in pictures)

post DDT-pre BDMPS

"He has a picture"- Gribov's highest compliment to a scientist

Vladimir Naumovich Gribov (1930-1997)

Legendary Gribov’s seminar



(no time limit + **aggressive friendliness**)

↓

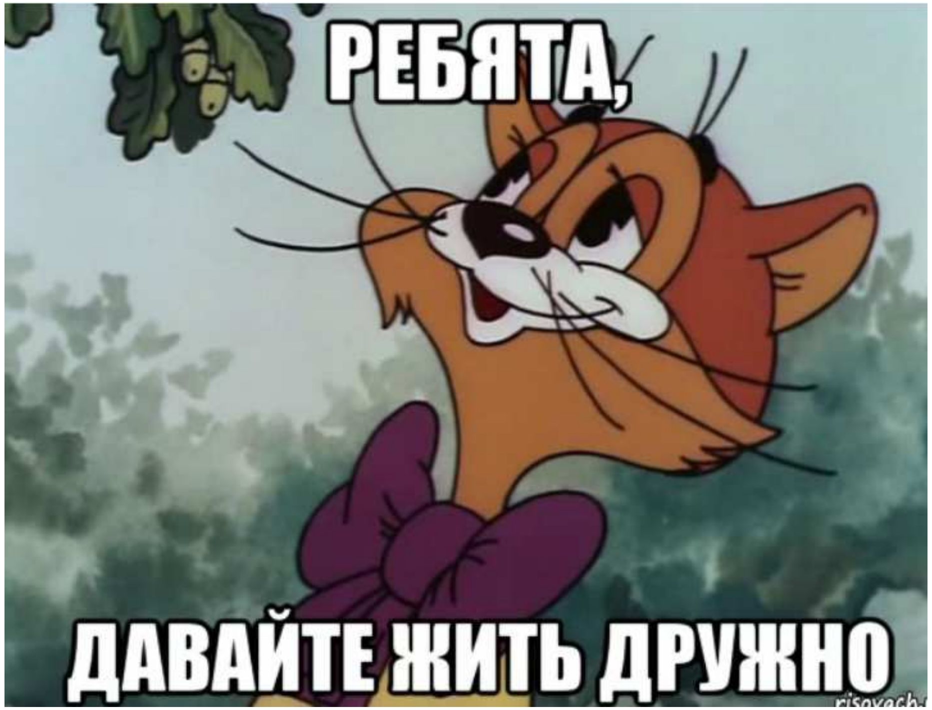
offensive

TRIAL BY GRIBOV’S SEMINAR

Unquestionable duties:

- To work(!) in the seminar.
- Have great respect for the experimentalists.

The theory which can’t be tested experimentally is not physics but a pure mathematics



GUYS LET’S LIVE AS FRIENDS

Dedication to Gribov’s scientific legacy

(together with Julia)

1) V.N. Gribov: 1930 - 1997.
By Yuri L. Dokshitzer.
[physics/9801025].
Submitted to: Phys.World.

2) Gribov program of understanding confinement.
By Yu.L. Dokshitzer.
[hep-ph/0510200].
10.1142/9789812778345_0002.
Sci.Cult.Ser.-Phys. 21 (2002) 60-79.

3) The Gribov conception of quantum chromodynamics.
By Yuri L. Dokshitzer, Dmitri E. Kharzeev.
[hep-ph/0404216].
10.1146/annurev.nucl.54.070103.181224.
Ann.Rev.Nucl.Part.Sci. 54 (2004) 487-524.

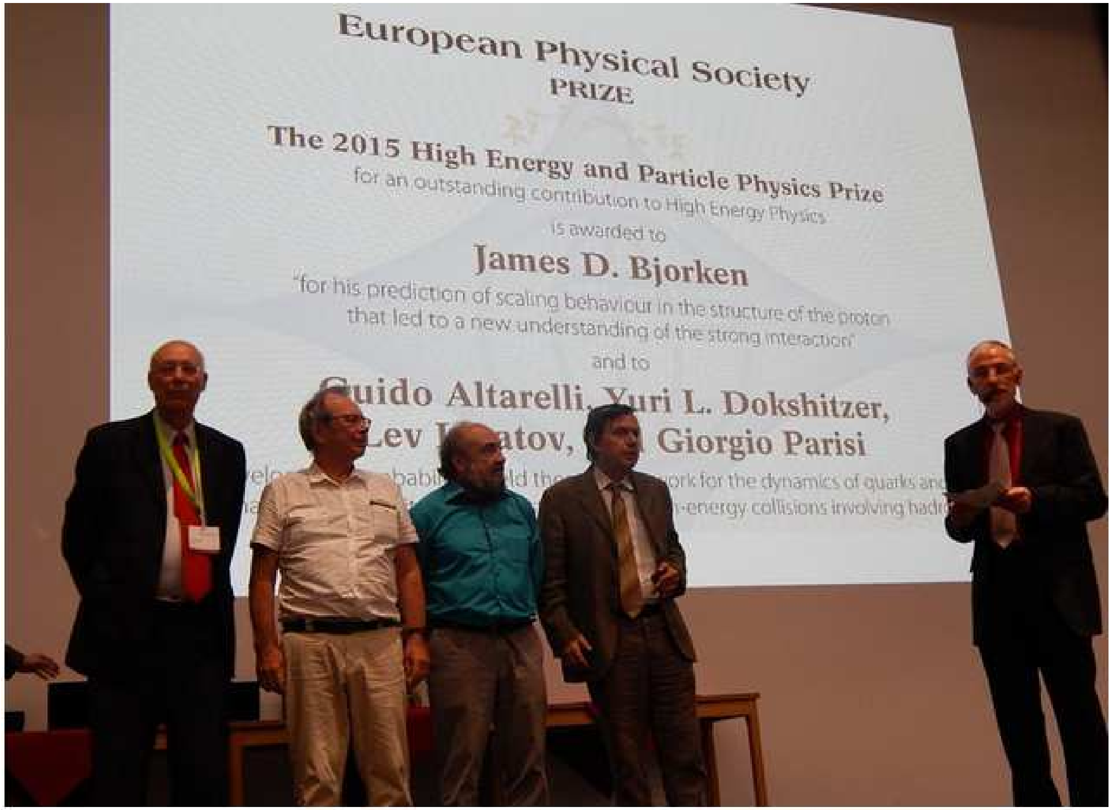
4) Gribov light quark confinement scenario.
By Yu.L. Dokshitzer.
10.1142/S0217751X0502793X.
Int.J.Mod.Phys. A20 (2005) 4363-4368.

5) Quarks, hadrons, and strong interactions: Gribov memorial volume. Proceedings, Memorial Workshop devoted to the 75th birthday of V.N. Gribov, Budapest, Hungary, May 22-24, 200
By Yu.L. Dokshitzer, P. Levai, J. Nyiri.

6) Strong interactions of hadrons at high emnergies: Gribov lectures on.
By Vladimir N. Gribov, Yuri L. Dokshitzer, Julia Nyiri.

7) Quantum chromodynamics and beyond: Gribov-80 memorial volume. Proceedings, Memorial Workshop devoted to the 80th birthday of V.N. Gribov, Trieste, Italy, May 26-28, 2010.
By Yuri L. Dokshitzer, Peter Levai, Julia Nyiri.
10.1142/8143.

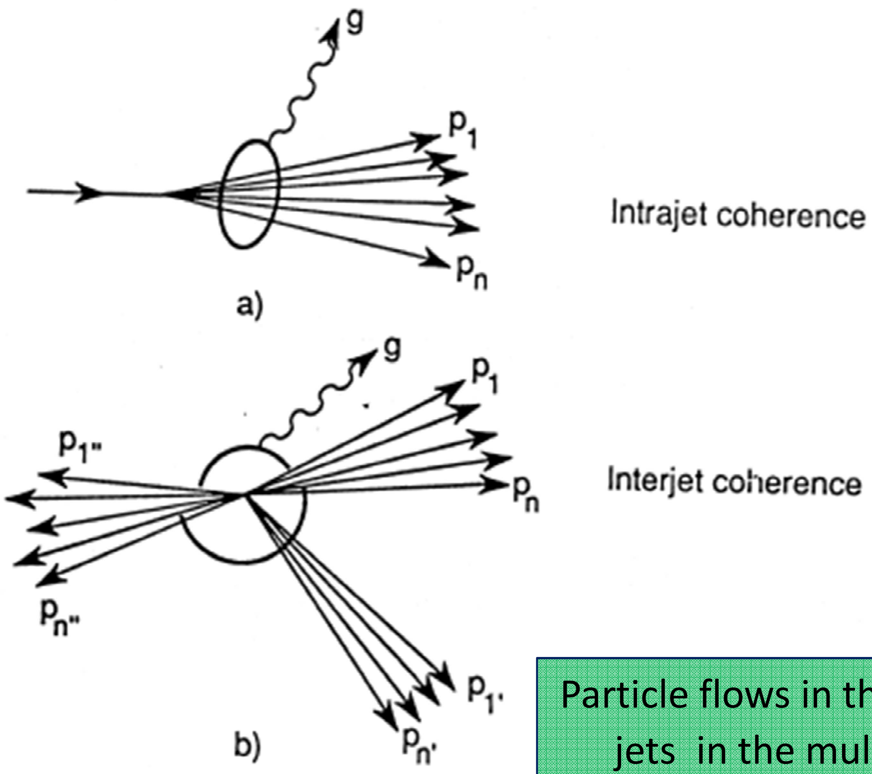
BETTER LATE THAN NEVER



QCD COHERENCE PHENOMENA

Coherence phenomenon is an intrinsic property of QCD (of any gauge theory)
An intimate connection is expected between the jetty event structure and underlying colour dynamics at small distances (LPHD)

Late 70th-abundant soft particle production-DGLAP-based expectation



Colour topology of the whole primary system

Particle flows in the regions between jets in the multi-jet processes.

Coherent soft gluon(hadron) radiation is governed by the colour charge of the parent gluon imagined to be on-shell.

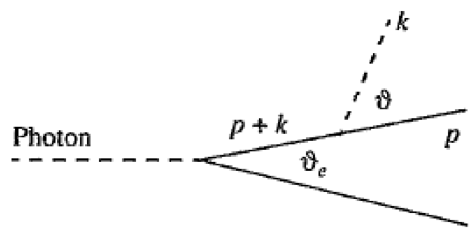
A good old QED precursor –Chudakov (or King-Perkins-Chudakov) effect, 1955 in cosmic -ray physics

Decreasing ionization losses for a narrow electron-positron pairs due to the internal screening of the constituents

Fig. 4. Electron track in the emulsion.

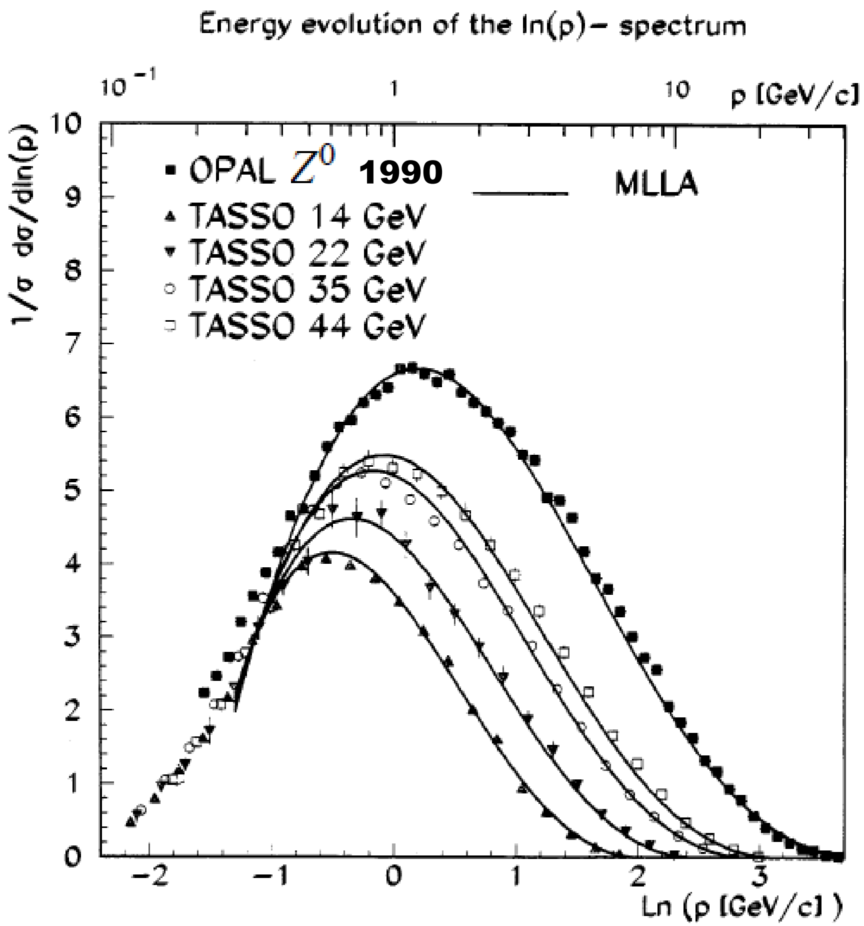
Fig. 5. Double-density track.

Fig. 6. Emulsion track of the e^+e^- pair.



ig. 7. Secondary photon radiation off the e^+e^- pair.

Hump-backed QCD plateau (DFK, ADK-1982)



(First results- Glen Cowan –ALEPH)

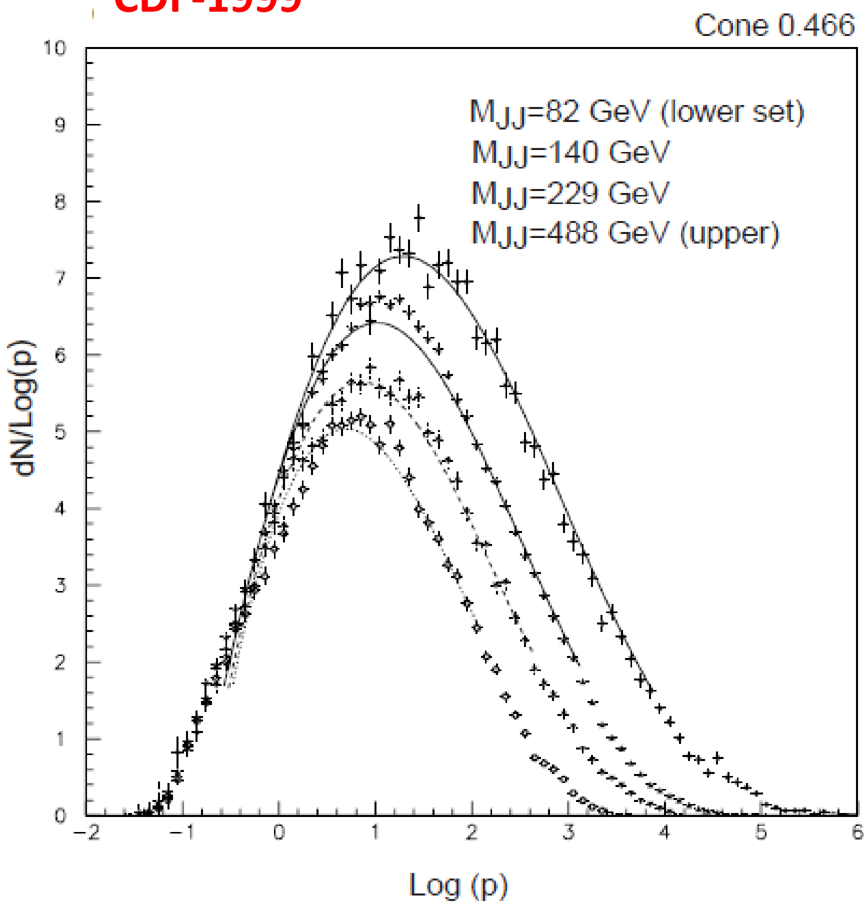
Branching parton cascade develops only in the region of sequentially shrinking angular cones (celebrated **AO**)
A.Mueller; B.Ermolaev & V. Fadin (1981)

Implemented in the WIGged MCs (Bryan)

Seen also at SLC, LEP 2, CDF, D0, TRISTAN, BaBar, DIS CF, in a good agreement with the **MLLA**

You have to find an enthusiastic experimentalist

CDF-1999



$dN/d\,log(p)$ distribution (4 dijet mass samples, cone 0.466).

(Andrey Korytov, CDF)

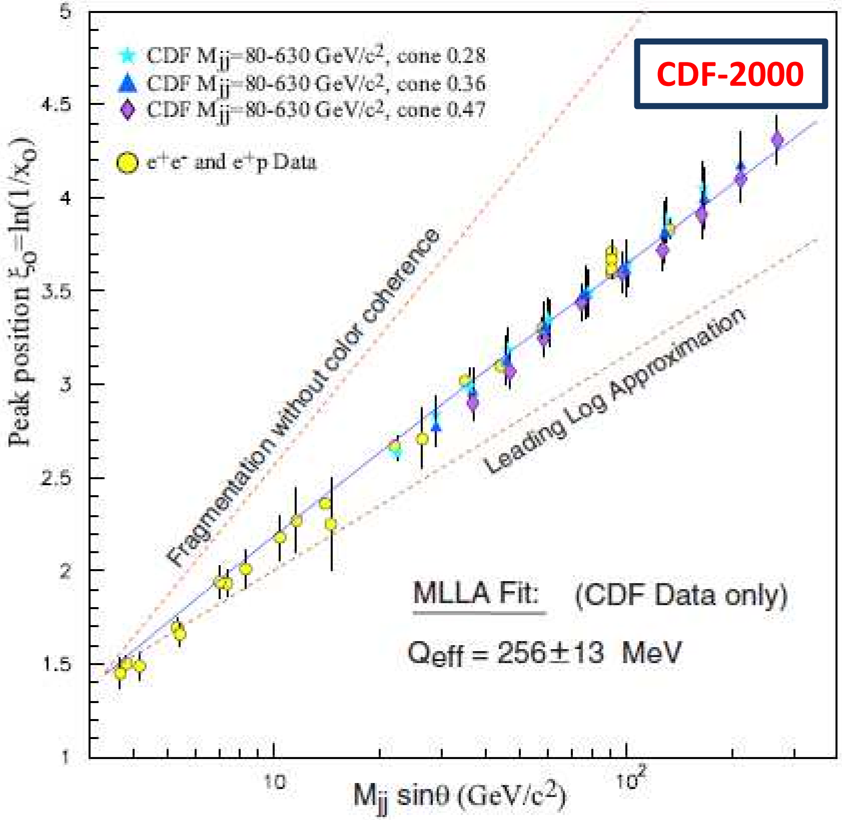
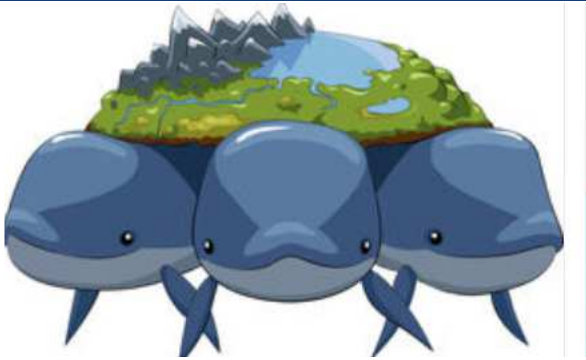


Figure 2. Peak position ξ^* of the inclusive ξ distribution plotted against di-jet mass $\times \sin\Theta_0$ in comparison with the MLLA prediction (central curve); also shown are (in arbitrary normalization) the double logarithmic approximation (lower curve with asymptotic slope $\xi^* \sim Y/2$) and expectation from cascade without coherence. Result by CDF Collaboration (2000)

purely analytical result!

Basics of Perturbative Approach to the jetty final states in hard processes



- **Space-time evolution of the branching parton cascade (ADK 1982)**

- **Concept of the Local Parton Hadron Duality (DT-1984, ADTK-1985)**

  Parton-Hadron conversion occurs locally at low virtualities leading to a close correspondence between the parton and hadron distributions.
  Nature is confirming that the non-PT dynamics is local in the configuration space and has a short memory.

- **Modified Leading Logarithmic Approximation (DT-1984, ADTK-1985)**

  Takes into account all essential ingredients of parton branching in the next-to-leading order.
  AO allows to maintain a probabilistic interpretation of the soft parton cascade.

RADIOPHYSICS OF HADRONIC FLOWS IN JETTY PROCESSES

$$e^+e^- \longrightarrow q\bar{q}g$$

Lund string-effect (AGS-1980) -purely non-PT (hadronisation string model)
Depletion of the flux in the qq valley.

First observed experimentally (JADE@PETRA) 1981

Leningrad Drag-effect
(ADTK-1985), purely PT, LO

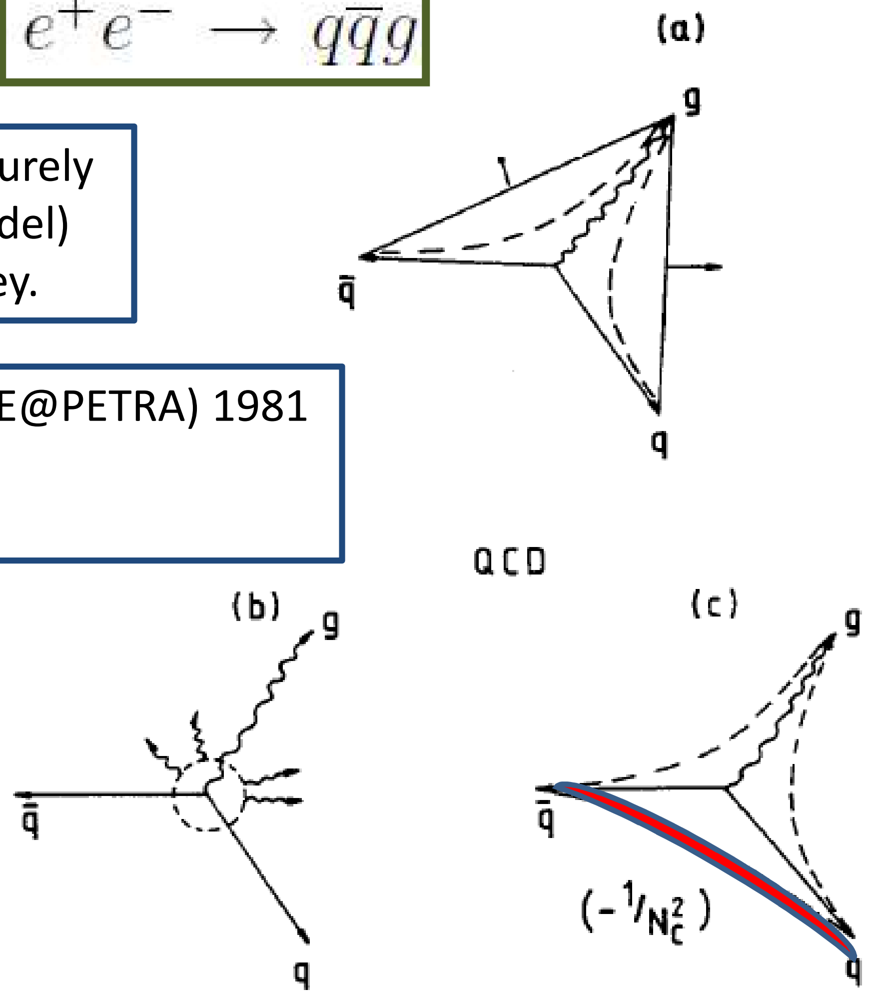
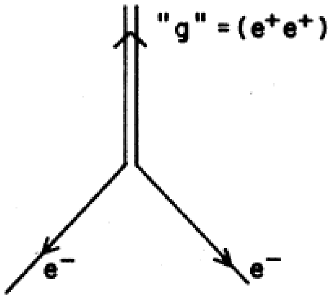


Fig. 6.3. String model (a) and perturbative QCD (b), (c) pictures for the $e^+e^- \to q\bar{q}g$ events. Dashed lines show topology of color strings. Dash-dotted line shows "negative antenna."



Abelian model for illustrating string effect. The "gluon" is represented as having double the electric charge of the electron.

$$N_C = \sqrt{2}\,(QED)$$

Electric field vanishes between the equal electric charges

For fully symmetric $q\bar{q}g$ events
midway between quarks

$$\frac{dN_{q\bar{q}g}/d\vec{n}_2}{dN_{q\bar{q}\gamma}/d\vec{n}_2} = \frac{N_C^2-2}{2(N_C^2-1)} \approx 0.44.$$

particle densities in the interquark valley in the $e^+e^- \to q\bar{q}g$ and $e^+e^- \to q\bar{q}\gamma$

first experimental confirmation-JADE(1988) Siggi Bethke

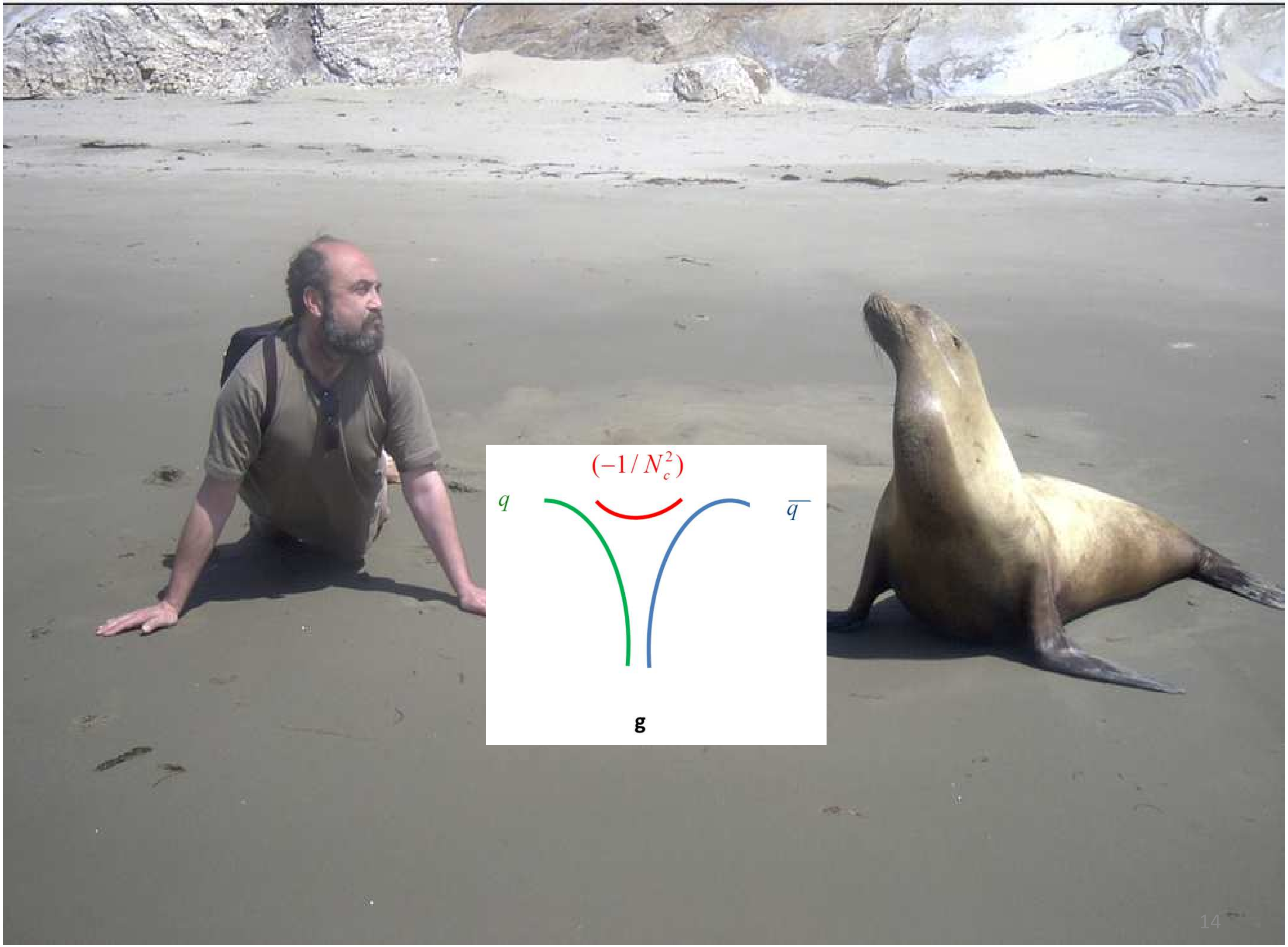
$$R_\gamma = \frac{N_{qq}(q\bar{q}g)}{N_{qq}(q\bar{q}\gamma)}$$

DELPHI- 1996

Y-shaped events

$$R_\gamma^{th} \approx \frac{0.65N_C^2-1}{N_C^2-1} \approx 0.61$$

$$R_\gamma^{\exp} = 0.58 \pm 0.06.$$


$(-1/N_c^2)$
q
$\overline{q}$
g

$$\frac{8\pi dN_{q\bar{q}\gamma}}{d\Omega_{\vec{n}_2}} = \frac{2C_F}{N_C}\,(\widehat{+-})\,N_g'(Y), \qquad \frac{8\pi dN_{q\bar{q}g}}{d\Omega_{\vec{n}_2}} = \left[(\widehat{1+}) + (\widehat{1-}) - \frac{1}{N_C^2}\,(\widehat{+-})\right] N_g'(Y).$$

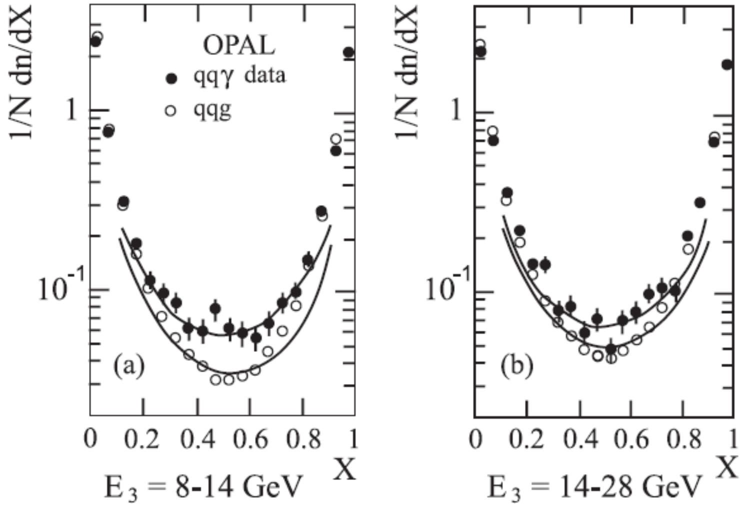


Fig. 1.3 Charged particle flow in between the two quark jets of the $q\bar{q}g$ and $q\bar{q}\gamma$ final states, as measured by OPAL [62], for two samples of energies E_3 of the lowest energy

OPAL-1995

X= φ/Θ_{+-}

(Curves BKO-2002)

Let us emphasize that in all drag-related measurements the inter-jet flows are dominated by the low energy hadrons (pions with typical momenta in the few 100 MeV range). It looks intriguing that such distant offsprings are controlled by the pQCD rules.

String-drag phenomena were seen in various jetty processes (LEP2, Tevatron, LHC).
offer a way to distinguish production mechanism using antenna patterns (EKS-1997)

$$R_\perp = \frac{N_C}{4C_F}[2 - \cos\Theta_{1+} - \cos\Theta_{1-} - \frac{1}{N_C^2}(1 - \cos\Theta_{+-})]$$

$q, \overline{q}, g$ (labeled as $+, -, 1$).

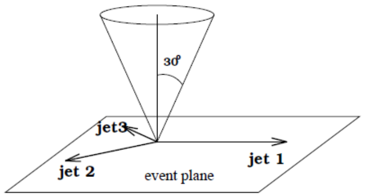


Figure 2: Definition of the cone perpendicular to the event plane

(Klaus Hamacher, DELPHI)

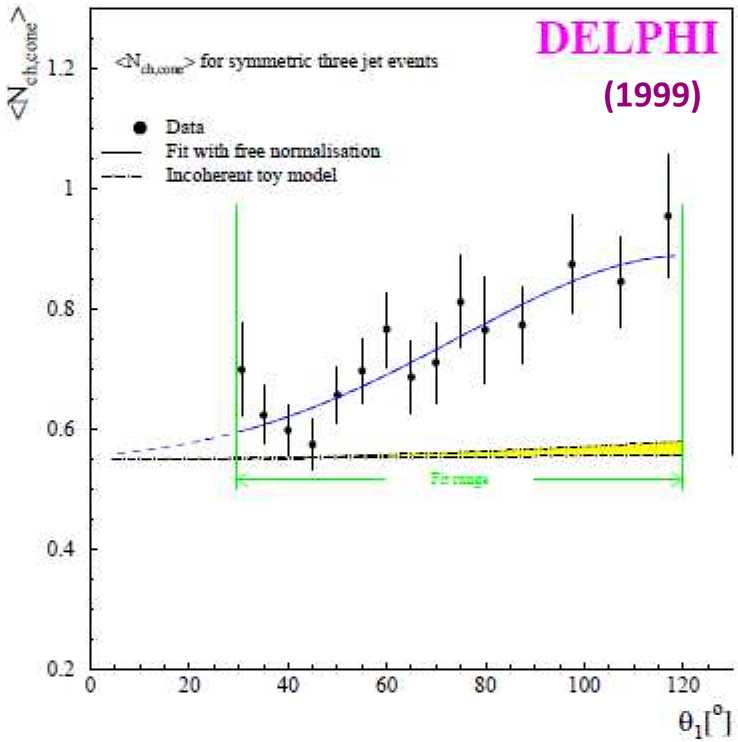
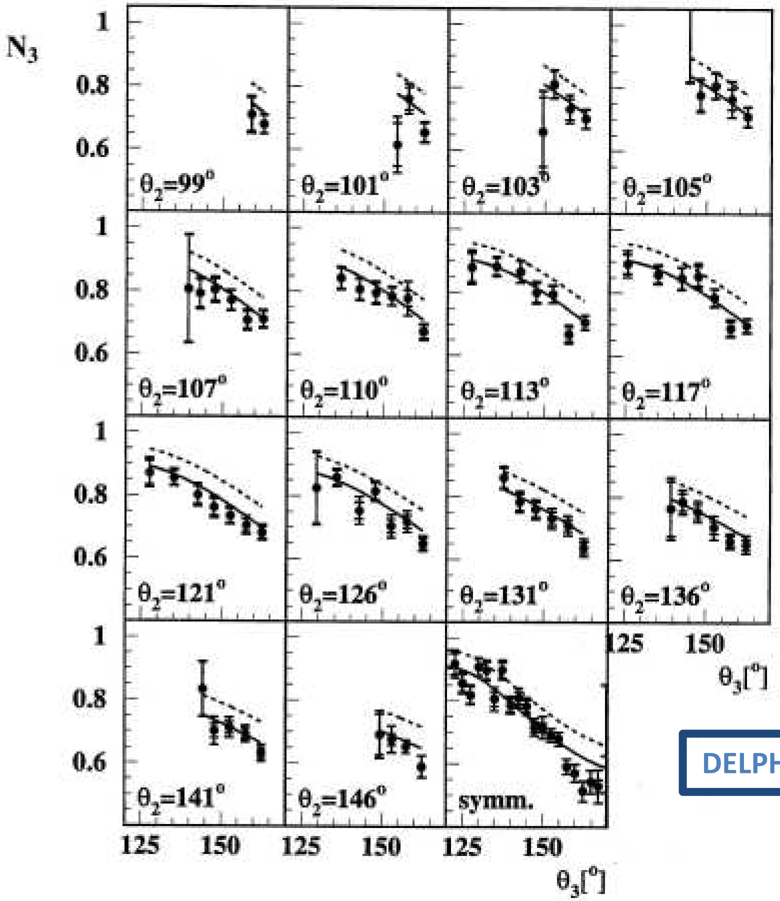


Figure 4. Multiplicity within a 30°-cone perpendicular to the event plane of symmetric three-jet events as a function of the angle Θ_1 between the low energy jets [26]. The curve represents the perturbative prediction (8).

First direct experimental verification of a colour-suppressed 'negative antenna ' (DELPHI-05)

C_A/C_F = $2.211 \pm 0.014(\text{stat.}) \pm 0.053(\text{syst.})$ $\chi^2/Ndf = 1.3$

(surprisingly good agreement with the colour factor ratio 9/4)



supports the assumption of LPHD for low hadron momenta

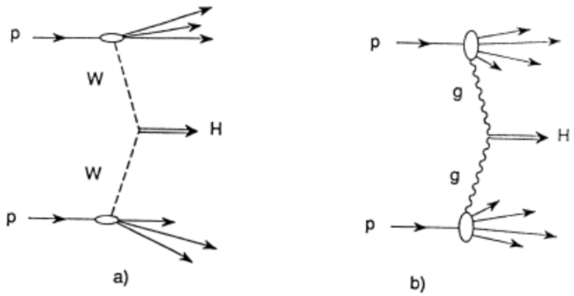
(Klaus Hamacher)

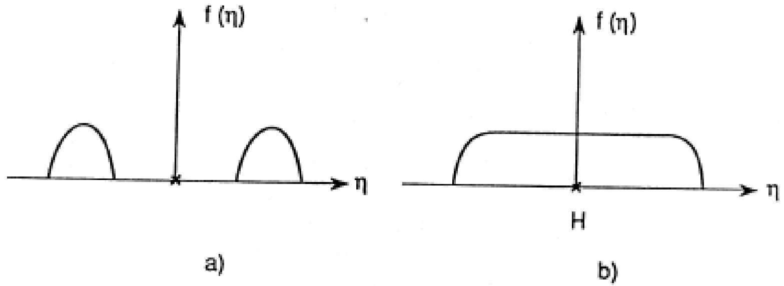
DELPHI(2005) Z-decays

Fig. 1.4 Multiplicity $N_3 = r_t N_2$ in cones of 30° opening angle perpendicular to the three-jet event plane, as a function of the angles ϑ_2, ϑ_3 [28]. The inner error bars are statistical, the outer also include systematic uncertainties. The solid line is the expectation from Equation 1.23. For the dashed line the term in Eq. 1.23 $\propto 1/N_C^2$ has been omitted. Without color suppressed interference, the multiplicity is significantly overestimated.

Hadronic antenna patterns as a tool to study New Physics (DTK-86)

Colour-singlet objects in pp collisions





First numerical estimate of the so-called gap survival probability- DSK-92

Hadronic antenna patterns as a tool to study New Physics (DTK-86)

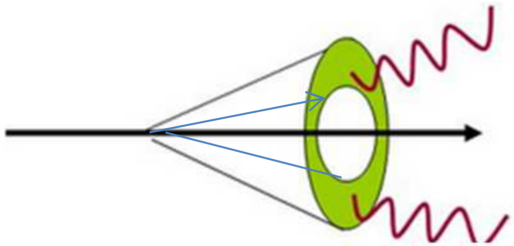
PHYSICAL REVIEW D VOLUME 47, NUMBER 1 1 JANUARY 1993

Rapidity gaps and jets as a new-physics signature in very-high-energy hadron-hadron collisions

J. D. Bjorken
Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309
(Received 30 March 1992)

In hadron-hadron collisions, production of Higgs bosons and other color-singlet systems can occur via fusion of electroweak bosons, occasionally leaving a "rapidity gap" in the underlying-event structure. This observation, due to Dokshitzer, Khoze, and Troyan, is studied to see whether it serves as a signature for detection of the Higgs bosons, etc. We find it is a very strong signature at subprocess c.m. energies in excess of a few TeV. The most serious problem with this strategy is the estimation of the fraction of events containing the rapidity gap; most of the time the gap is filled by soft interactions of spectator degrees of freedom. We also study this question and estimate this "survival probability of the rapidity gap" to be of order 5%, with an uncertainty of a factor 3. Ways of testing this estimate and further discussion of the underlying hard-diffraction physics are presented.

DEAD CONE EFFECT (DKT-86, DKT-91)



- Gluon radiation in the vacuum is modified by a mass of the parent quark: radiation for angles $\theta < m/E$ is suppressed, the dead cone effect

(Dokshitzer, Khoze, Troyan, JPG17(91)1481):

Dead cone factor

$$\frac{1}{\mathbf{k}_\perp^2} \to \frac{1}{\mathbf{k}_\perp^2}\left[\frac{\mathbf{k}_\perp^2}{\mathbf{k}_\perp^2 + \left(\frac{m\omega}{E}\right)^2}\right]^2 \equiv \frac{1}{\mathbf{k}_\perp^2} F\left(\mathbf{k}_\perp^2, \frac{m\omega}{E}\right).$$

0-0 transition in nuclei

Experimental evidence in c- and b-quark jets: DELPHI-2004, H1-2006

- *Leading particle effect in heavy-quark fragmentation* (PT-QCD, DTK-86)

- Gluon radiation off heavy quarks in a QCD medium (Dokshitzer, Kharzeev, PLB519(01)199)

UNCLASSIFIED

ORNL 792

8A

Date Issued: SEP 6 1950

S.D. Drell

NOTE ON ZERO-ZERO TRANSITIONS

OAK RIDGE NATIONAL LABORATORY · U.S. ATOMIC ENERGY COMMISSION

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS DIVISION
UNION CARBIDE AND CARBON CORPORATION
UCC
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

UNCLASSIFIED

VISUALISATION OF THE DEAD CONE

$$\delta_{Q\ell} = N_Q^{ch}(W) - N_q^{ch}(W) = \text{const}(W),$$
$$\delta_{bc} = N_b^{ch}(W) - N_c^{ch}(W) = \text{const}(W),$$

with $Q = b, c$ and $\ell \equiv q = u, d, s.$

power accuracy, $1 + \mathcal{O}(M^2/W^2)$

$$N_{q\bar{q}}(W) - N_{Q\overline{Q}}(W) = N_{q\bar{q}}(\sqrt{e}M)\cdot[1+\mathcal{O}(\alpha_s(M))],$$ (MLLA)

$$\delta_{bc}^{MLLA} = 2.9 \pm 0.6, \qquad \delta_{bc}^{exp} = 2.1 \pm 0.4,$$

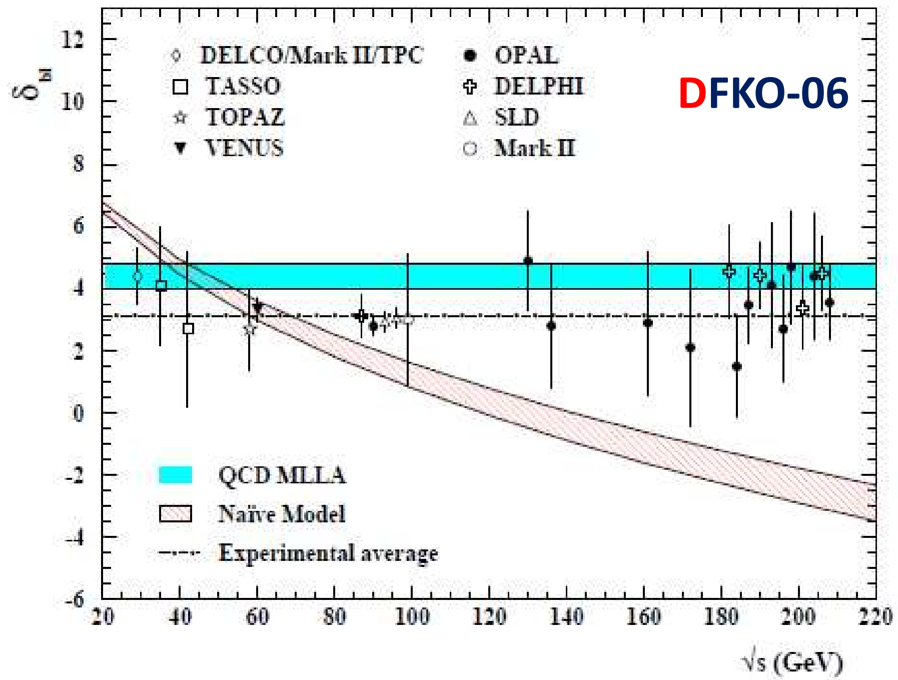


Figure 2: Experimental measurements of $\delta_{b\ell}$ plotted as a function of the c.m.s. energy, $\sqrt{s}$; data below 90 GeV reevaluated (see Appendix B.2). The revised MLLA expectation using $\delta_{b\ell}^{MLLA} = 4.4 \pm 0.4$ is indicated by the shaded area. Also shown is the "naïve model" [16] based on the reduction of energy scale (dashed area).

RESURRECTION

Resurrecting the Dead Cone

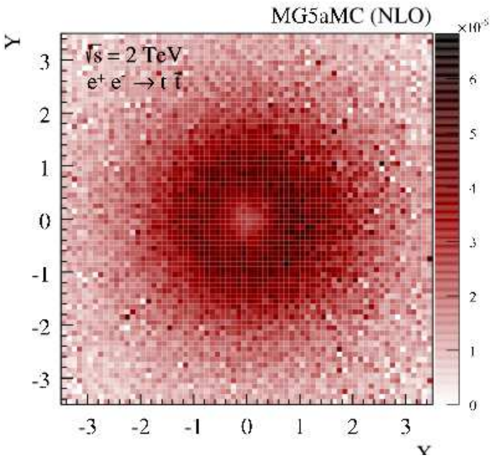
arXiv:1606.03449

Fabio Maltoni,[1,*] Michele Selvaggi,[1,†] and Jesse Thaler[2,‡]

[1] *Centre for Cosmology, Particle Physics and Phenomenology CP3, Université Catholique de Louvain, Chemin du Cyclotron, 1348 Louvain la Neuve, Belgium*

[2] *Center for Theoretical Physics, Massachusetts Institute of Technology, Cambridge, MA 02139, US*

The dead cone is a well-known effect in gauge theories, where radiation from a charged particle of mass m and energy E is suppressed within an angular size of m/E. This effect is universal as it does not depend on the spin of the particle nor on the nature of the gauge interaction. It is challenging to directly measure the dead cone at colliders, however, since the region of suppressed radiation either is too small to be resolved or is filled by the decay products of the massive particle. In this paper, we propose to use jet substructure techniques to expose the dead cone effect in the strong-force radiation pattern around boosted top quarks at the Large Hadron Collider. Our study shows that with 300/fb of 13-14 TeV collision data, ATLAS and CMS could obtain the first direct evidence of the dead cone effect and test its basic features.



Volume 181, number 1,2 PHYSICS LETTERS B 27 November 1986

10 years prior to the top quark experimental discovery

CDF and DØ
1995

PRODUCTION AND DECAY PROPERTIES OF ULTRA-HEAVY QUARKS ☆

RAPALLO PAPER

I. BIGI [1]
Stanford Linear Accelerator Center, Stanford University, Stanford, CA 94305, USA

Y. DOKSHITZER, V. KHOZE
Leningrad Nuclear Physics Institute, Leningrad, USSR

J. KÜHN
Max-Planck-Institut für Physik, D-8000 Munich, Fed. Rep. Germany

and

P. ZERWAS
CERN, CH-1211 Geneva 23, Switzerland

Received 8 September 1986

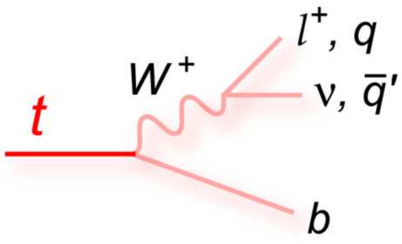
The widths of ultra-heavy quarks that can decay into W, Z or Higgs bosons are discussed. If the lifetimes become much shorter than the typical strong interaction time scale $\Lambda_{QCD}^{-1} \sim 10^{-23}$ s, then open-flavor hadrons and quarkonium bound states cannot be formed any more. Consequences for the jet evolution are investigated. On the other hand, if such quarks can decay only through tiny mixing angles – as it could happen for sequential down-type quarks and for SU(2) singlet quarks in E_6 models – then these bound states do form. Production rates for quarkonia in e^+e^- annihilation and in hadronic collisions are estimated and their decay signatures are discussed.

long before:
a search for a
land free from
hadronisation
enslavement

$Q \to q + W/Z$ (H)

$\Gamma(Q \to q + W) \simeq 180\,\mathrm{MeV} \times |V(Qq)|^2 (m_Q/m_W)^3$

the lifetime drops below 10^{-23} s



Top width ≈ 1.4 GeV $\gg \Lambda_{QCD}$.

- t-flavoured hadrons are not formed **('true bare quark').**
- Toponium bound states do not appear.
- Original spin orientation is preserved, spin correlations.
- Some nice QCD results - **lost in translation** 

Threshold scan –bread and butter of ILC, CLIC, FCCee..
(e^+e^- top pair threshold)


WELCOME
TO
LATVIA


Welcome To
The Future


15 THINGS TO DO IN
RIGA

BACKUP