G V 80 CERN 07/09/2022

(QCD) Jet Calculus

KK, Ukawa, Veneziano

"A simple algorithm for QCD Jets", Phys. Lett. 78B (1978)

"Jet calculus, a simple algorithm for resolving QCD Jets", Nucl. Phys. B157 (1979)

"On the transverse spread of QCD Jets", Phys. Lett. 80B (1979)

Backgrounds

'78

- QCD perturbation theory in “Hard Processes” (deep-inelastic eP scattering, $e^+e^- \to$ hadrons, etc) understood - Altarelli-Parisi, factorization theorem, etc.
- $e^+e^- \to$ 1 particle + everything (1 parton “inclusive” cross sections)

52 *K. Konishi et al. / Jet calculus: a simple algorithm for resolving QCD jets*

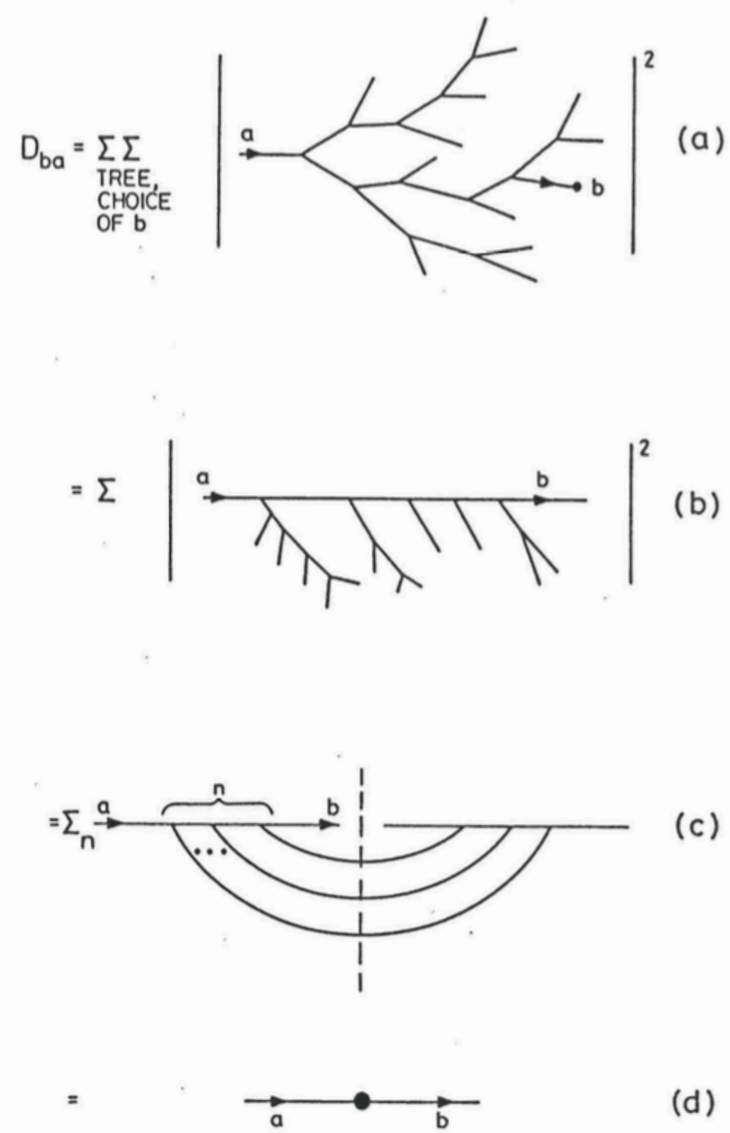


Fig. 1. (a) Jets as branching processes in the LLA. (b) Choosing one final parton. (c) Reconstructing a dressed ladder. (d) Evolution a → b à la Altarelli-Parisi.

$D_{ba}(x, Q^2)$
fragmentation function (cfr structure fn)

Leading log approx;
Axial gauge, etc.

Idea

- Pull out one more parton from (i.e. undo) the sum!

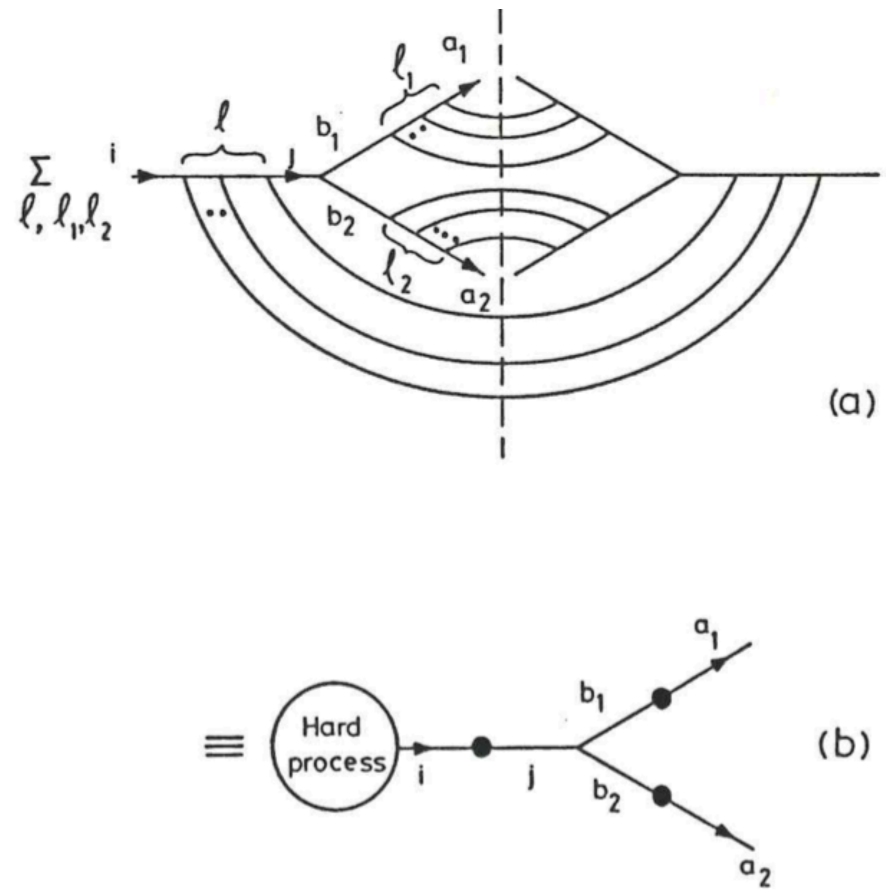


Fig. 2. (a) Choosing two final partons in fig. 1a and reconstructing a triple ladder. (b) Evolution $i \to a_1 + a_2$ described by eq. (2.8).

= 2 parton inclusive cross sections

$D_i^{a_1,a_2}(x_1, x_2, Q^2)$

☞ Generalization to multi-parton inclusive cross sections

simple diagrams

Jet calculus

Jet calculus

- Various checks (sum rules, etc.) including the rederivation of m-parton exclusive cross sections for $\lambda\phi^3$ in 6D ! J.C.Taylor
- Transverse momentum distributions in quark and gluon jets
- Jet-energy spread KUV
- Multiplicity and multiplicity distributions

$\langle n(Q^2)\rangle$

$\langle n\rangle_q / \langle n\rangle_g$

Double Leading log summations;

K.K., A. Mueller

- Jet calculus to next-to-leading order

K.K., Kalinowski, Scharback, Taylor,

Gunion, Kalinowski, Symanowski,

- Preconfinement

Amati, Veneziano

Perturbative QCD ⟶

probabilistic algorithm for computing measurable m parton (x, p_T) distributions

All the (quark-, gluon-, hadron-) jet simulation programs

All these things are (perhaps) well known …

A personal recollection:

'84

GV contributed to the discovery of the "Konishi anomaly", by

supersymmetric gauge theories

squark condensate in SQCD

(1) explaining to me his wrong (naive) argument leading to $\langle q\tilde{q}\rangle = 0$

(2) understanding and appreciating at once my derivation of the anomaly by point-splitting method;

(3) helping me in completing the work;

(4) refusing my offer to him to sign the paper as a coauthor; and

(5) remarking, a few days later, walking together along the CERN corridor:

" It was a lesson to me: I had a prejudice that in supersymmetric theories the operator products must be less singular… You know, when one does not know anything (about the subject), one goes ahead and, perhaps, finds out the right answer … "

♦ ♦ ♦ ♦ ♦

☞ A moral lesson for young theorists:

DON’T LISTEN TO WHAT THE BIG EXPERTS SAY:
THINK WITH YOUR OWN HEAD !

G V 8 0 C E R N 0 7 / 0 9 / 2 0 2 2

Grazie, Gabriele,
Auguri per
Cento di questi giorni !

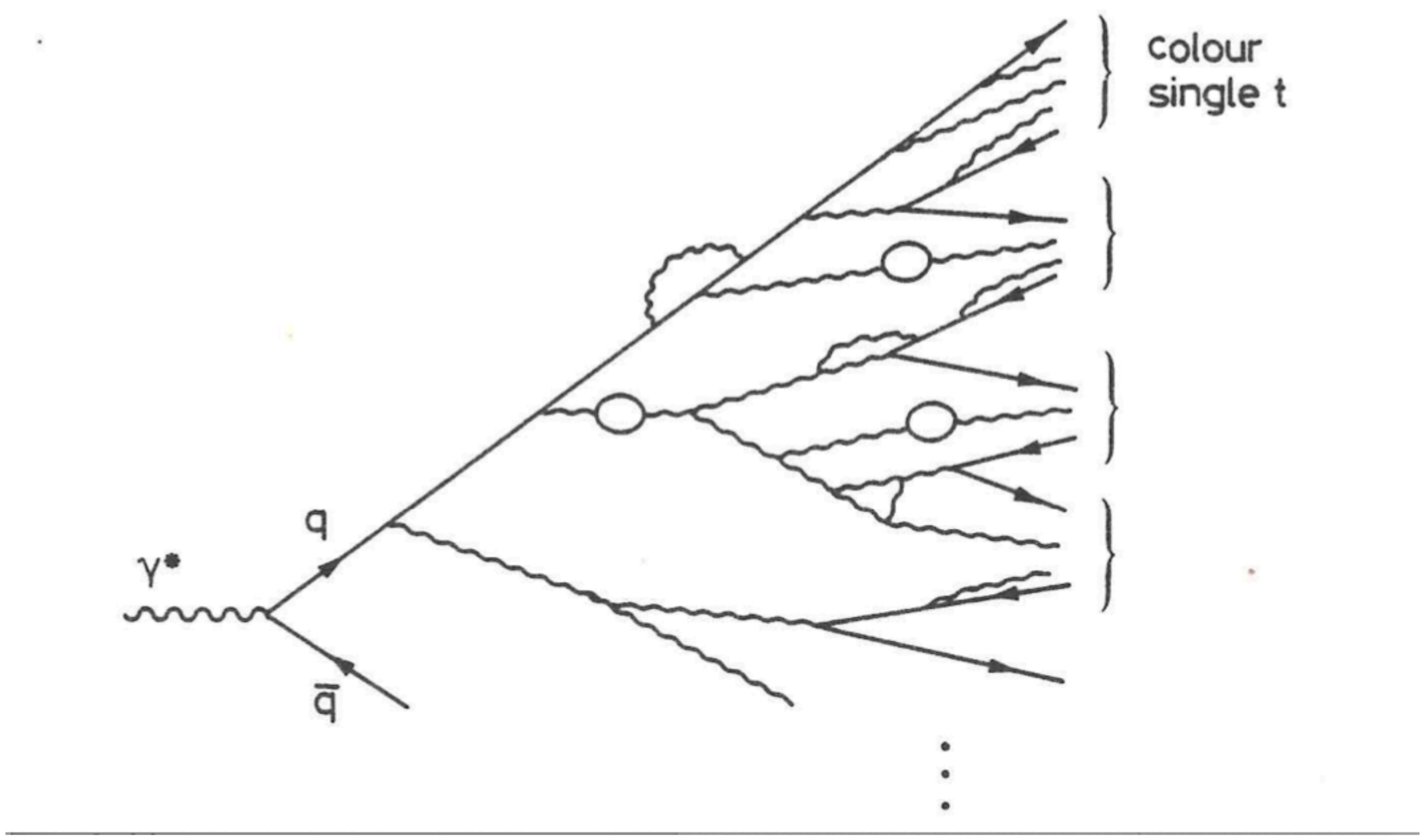
Ken

Multiplicity and multiplicity distributions

$$\langle n(Q^2)\rangle \sim e^{2\sqrt{\frac{C_A}{\pi b}}\sqrt{\log Q^2}}$$

$$\frac{\langle n^{ch}\rangle_{q-jet}}{\langle n^{ch}\rangle_{g-jet}} = \frac{C_F}{C_A}\,, \qquad \langle n^{ch}(n^{ch}-1)\rangle \qquad \ldots$$

Preconfinement



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