

Minutes of the Meeting on QCD at LEP II of 12.3.93

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Agenda:

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|---|--------------------------------|
| Color exchange in $W^+W^- \rightarrow q\bar{q}q\bar{q}$ | Michael Schmelling |
| $q\bar{q}$ -event selection at 180 GeV | Pedro Saraiva |
| α_s from scaling violations | Christobal Padilla/ Glen Cowan |

At the meeting on 10.2.93, Alex Finch was requested to compile a list of references on two photon physics for use by interested persons. The list is given in these minutes before the copies of transparencies.

Michael Schmelling gave a theoretical discussion of color exchange in $W^+W^- \rightarrow q\bar{q}Q\bar{Q}$. First, a review of the color string model for hadron production was given. The string represents a one dimensional flux tube of color fields, and corresponds to a classical potential $V \approx \kappa \cdot r$. Hadron production results from breakup (i.e. decay) of the string.

For the case of $W^+W^- \rightarrow q\bar{q}Q\bar{Q}$ at threshold, one has two ways of connecting strings between the four color charges: between $q\bar{q}$ and $Q\bar{Q}$ (two long strings, each with a mass of the W^\pm) or between $q\bar{Q}$ and $Q\bar{q}$ (two short strings, i.e. smaller mass). This has been investigated by Gustafson, Pettersen and Zerwas, Phys. Lett. **B209** (1988) 90, who point out that the "short" and "long" string cases lead to substantially different event properties.

M.S. used simple (?) quantum mechanical arguments to estimate the relative probabilities of the "short string" and "long string" scenarios as a function of center-of-mass energy. He obtains

$$\begin{aligned} \frac{P_{short}}{P_{long}} &\approx \exp \left[- \left(\frac{\Lambda_{QCD}\sqrt{s}}{\Gamma_W 2M_W} \right)^k \right] \cdot \frac{1}{9} \cdot \left(\frac{1 + \alpha_s \frac{4}{3} + \alpha_s^2 \frac{14}{9}}{1 + \alpha_s^2 \frac{4}{9}} \right)^2 \\ &\approx \left(\frac{1}{7} \dots 1 \right) \exp \left(\frac{-0.12\sqrt{s}}{2M_W} \right) \end{aligned}$$

(See transparencies for details.) Although it has been suggested that the color exchange effect should only be present near the W^+W^- threshold, the formula above suggests that P_{short} could be measurable even at substantially higher energies.

It was suggested to try to incorporate color exchange pairing in a Monte Carlo model (e.g. PYTHIA) in order to investigate how well the "short" and "long" string events could be separated.

Pedro Saraiva gave a talk on the selection of $q\bar{q}$ events at $E_{cm} = 180$ GeV. The main motivation is to use the $q\bar{q}$ events to measure α_s in the same manner as at LEP I (e.g. using thrust). It was pointed out that although one will have less events at LEP II, the

hadronization effects are expected to be smaller, allowing one to use a larger region of the thrust (or whatever) distribution.

Two problems were investigated: initial state radiation and background from $W^+W^- \rightarrow q\bar{q}q\bar{q}$. Because of the pole of the Z-propagator, the probability of initial state photon is dramatically increased for $E_{cm} > M_Z$. For $E_{cm} = 180$ GeV such events have a photon of around 67 GeV which escapes down the beam-pipe, and a hadronic system with a visible mass $M_{vis} \approx M_Z$ boosted in the opposite direction of the photon. This leads to very large distortions in event shape distributions, which would severely complicate the measurement of α_s .

A Monte Carlo study was done with PYTHIA 5.5 using all final state particles (except neutrinos) having $|\cos\theta| < 0.95$. Studies with the full GALEPH detector simulation should be carried out soon. By requiring

$$\frac{|\sum p_z|}{\sum |p|} < 0.1 \quad (1)$$

and

$$M_{vis} > 130\text{GeV} , \quad (2)$$

it was shown that the thrust distribution, although originally very distorted from the effects of initial state radiation, could be sufficiently restored to allow a measurement of α_s .

At $E_{cm} = 180$ GeV the W^+W^- -events are a potentially serious background to the $q\bar{q}$ sample. The main problem is from the case where both W's decay into hadrons. Although most of these events (assuming no color exchange!) have a low thrust, four-jet structure, there is a substantial number in the medium to high thrust region ($0.8 < T < 0.95$) where one would like to measure α_s . A scheme was studied where four jets were reconstructed, and jet-pair masses were examined to determine which pairs came from the W's. Although it appears to be a promising method to identify W^+W^- events, its effect on event shape distributions is still under study.

Glen Cowan presented a study done by Cristobal Padilla and Ramon Miquel (who could not attend) on the possibility to measure α_s using scaling violations in inclusive momentum distributions. This would allow ALEPH to measure α_s by combining data from 91 and 180 GeV. In addition, this could (should) be done as soon as possible using the current data and published distributions from PEP and PETRA. As in the case of the event shape variables, it was seen that effects of initial state radiation are important at higher energies. It is hoped to have a more complete discussion of this topic at one of the next meetings.

General references for gamma gamma

Workshop write ups:

- 1981 Paris Photon Photon Interactions G.W.London ISBN 9971-83-091-4 W.S.P.
1983 Aachen Photon Photon Collisions ed Ch.Berger ISBN 3-540-12691-0 S.V.
1984 Lake Tahoe Photon-Photon Collisions ed R.L.Lander, ISBN 9971-978-22-9
1986 Paris
1988 Shoresh
1992 San Diego Photon Photon Collisions ed D.O.Calwell and H.P.Paar ISBN
981-02-1053-1 W.S.P.

S.V. = Springer Verlag
W.S.P. = World Scientific Publishing

Reviews:

Two Photon Physics, Kolanoski, and Zerwas. DESY 87-175

(Very detailed, all the formalism ...)

V.M.Budnev, I.F.Ginzburg, G.V.Meledin, V.G.Serbo
The Two-Photon Particle Production Mechanism. Physical Problems.
Applicaions. Equivalent Photon Approximation.
Physics Reports (Section C of Physics Letters) 15, no4 (1975) 181-282

For specific work towards LEP II see LEP 200 workshop at Aachen:
CERN 87-02, ECFA 87/108, volume 1, pp202-250.