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THE DOUBLE-JET STRUCTURE OF PLANAR EVENTS PRODUCED IN pp INTERACTIONS AT $\sqrt{s}$ = 62 GeV

M. Basile[1], G. Cara Romeo[2], L. Cifarelli[2], A. Contin[3], G. D'Alì[2], P. Di Cesare[2], B. Esposito[4], P. Giusti[2], T. Massam[2], R. Nania[5], F. Palmonari[2], G. Sartorelli[2], M. Spinetti[4], G. Susinno[4], G. Valenti[1] and A. Zichichi[3]

ABSTRACT

Evidence is reported that in the multiparticle hadronic systems produced in low-p_T, and high-energy pp interactions at $\sqrt{s}$ = 62 GeV, effects similar to those producing the three-jet structure in e^+e^- annihilations, appear to be present.

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1) Istituto di Fisica dell'Università, Bologna, Italy.
2) Istituto Nazionale di Fisica Nucleare, Bologna, Italy.
3) CERN, Geneva, Switzerland.
4) Istituto Nazionale di Fisica Nucleare, Lab. Naz., Frascati, Italy.
5) Istituto Nazionale di Fisica Nucleare, Bari, Italy.

In e^+e^- physics the three-jet structure has recently been reported [1,2]. This peculiar structure is interpreted as the production, in e^+e^- annihilation, of two quark-induced jets plus a third jet induced by a gluon. This three-jet structure would correspond in our case to a two-jet structure, both jets being in the same hemisphere as that of the "leading proton". We have attempted to reveal this effect in our "minimum bias" sample of proton-proton, low-p_T data at $\sqrt{s}$ = 62 GeV.

The experiment has been done at the CERN Intersecting Storage Rings (ISR) using the Split Field Magnet facility (SFM).

For details we refer the reader elsewhere [3,4]. The sample of "minimum bias" events has been analysed according to the following criteria. Each event has been divided into two hemispheres and each hemisphere has been first selected, by requiring the presence of a "leading proton". This is defined as the fastest positive charged particle with $\Delta p/p \leq 8\%$, in the range $0.4 \leq x_F \leq 0.9$ ($x_F = 2p_L/\sqrt{s}$, p_L is the momentum component in the beam direction, $\sqrt{s}$ is the total c.m. energy of the colliding protons). Moreover at least four charged particles, besides the proton, are required.

In our previous paper [5] we have shown the existence of planarity effects in the multiparticle systems produced in pp interactions.

Following Bjorken and Brodsky [6], a two-dimensional momentum tensor, for the N particles accompanying the proton, has been evaluated for each event in the plane orthogonal to the proton-proton line of flight in the proton-proton rest system

$$M_{\alpha\beta} = \sum_{j=1}^{N} p_{j\alpha} p_{j\beta} \quad (\alpha,\beta = 1,2) \ .$$

The ordered eigenvalues Λ_1, Λ_2 ($\Lambda_1 < \Lambda_2$), are respectively the sum of the square of the momentum components, normal to the event plane (out), and in the event plane (in),

$$\langle p_T^2 \rangle_{out} = \frac{\Lambda_1}{N} = \frac{1}{N} \sum_{j=1}^{N} p_{j\,out}^2$$

$$\langle p_T^2 \rangle_{in} = \frac{\Lambda_2}{N} = \frac{1}{N} \sum_{j=1}^{N} p_{j\,in}^2 .$$

In order to study the behaviour of "planar" events we have imposed the condition:

$$\langle p_T^2 \rangle_{in} \geq 3 \langle p_T^2 \rangle_{out} .$$

To sum up all boundary conditions:

1) $\Delta p/p \leq 8\%$ } for the "leading" proton,
2) $0.4 \leq x_F \leq 0.9$ }

3) $n_{charged} \geq 4$ } for the particles accompanying the proton.
4) $\langle p_T^2 \rangle_{in} \geq 3 \langle p_T^2 \rangle_{out}$ }

The total number of events was 3614. In order to analyse the structure of these events, the thrust T was firstly evaluated in the pp c.m. system. Then, for each event a thrust T^* in the rest system of the charged particles [2] was calculated. This system should correspond to the c.m. system of the jet, on the hypothesis that the non-observed particles (neutrals plus those escaping from the detector) are evenly distributed in the c.m.. T^* is defined as

$$T^* = \max \frac{\Sigma_i |p_{Li}^*|}{\Sigma_i |p_i^*|} ,$$

where p_{Li}^* is the component along a given axis of the momentum p_i^* of the particle i in the rest system of the charged particles observed. The thrust quantity is 1 when all the particles in the event have exactly the same direction, and approaches 0.5 for events distributed symmetrically in a sphere. In the case of perfectly planar events, distributed symmetrically in the plane, the thrust approaches the value of $2/\pi$.

In fig. 1 the average values of T^* versus T, for experimentally observed events (3614) and for Monte Carlo generated events (5500), are reported. The experimental data show increasing T^* values when T decreases. Therefore "planar" events have a two-jet structure. This effect is not present in the Monte Carlo generated data. The Monte Carlo simulation is based on "limited p_T" ($\langle p_T \rangle \simeq$ $\simeq 0.300$ GeV/c) phase-space events, with identical boundary conditions (1, 2, 3, 4 above). Monte Carlo events with low thrust, i.e. flat, show no correlation with high-T^* events. This means that the two-jet structure is not present in the Monte Carlo generated events; thus the correlation observed in fig. 1 must be a genuine effect: the more a jet is wide in the pp c.m. system, the narrower it is in the jet rest system. This is the evidence for a two-jet structure in the multiparticle hadronic systems produced in high-energy, low-p_T, pp interactions.

As mentioned earlier, this two-jet structure is a further analogy between the two ways, e^+e^- and pp, of producing multiparticle hadronic systems.

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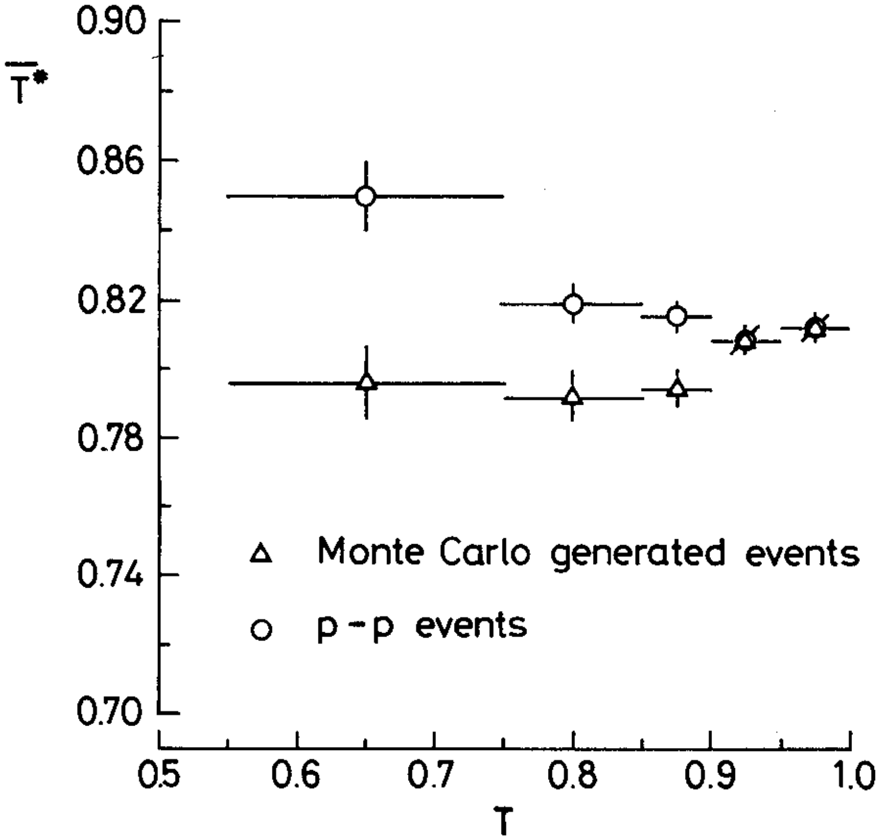
Figure caption

Fig. 1 : $\bar{T}^*$ versus T ranges for experimentally observed events and Monte Carlo generated events.



0.90
$\overline{T^*}$
0.86
0.82
0.78
0.74
0.70
0.5
0.6
0.7
0.8
0.9
1.0
T
Δ Monte Carlo generated events
○ p - p events

Fig. 1