QUANTUM NUMBER EFFECTS IN EVENTS WITH A CHARGED PARTICLE AT LARGE TRANSVERSE MOMENTUM

(CHARGE CORRELATIONS IN JETS)

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ABSTRACT

Charge correlations of particles in an event with a large p_t trigger particle have been measured. The correlation length for the charge compensation of the hard scattered parton fragments is the same as observed in nondiffractive inelastic events. Part of the charge of the large p_t trigger particle is compensated by the soft particles of the "away jet". For the spectator fragments the same charge correlation distributions are observed as for nondiffractive inelastic events.

§ 1 INTRODUCTION

We present experimental results on charge correlations between particles produced in an event with a large p_t trigger [1,2]. By the application of proper cuts we try to study separately the charge compensation for particles of each of the four jets ("trigger jet", "away jet", "spectator jets") which occur in a large p_t event[3,4]. The measured distributions are compared with the corresponding ones observed in nondiffractive inelastic events [2,5].

The analysis is based on a sample of events with a positive or a negative large p_t trigger particle ($<p_T> = 2.5$ GeV/c) produced at a polar angle of $<\theta_\tau> \approx 45^o$ [4,6]. The measurements have been performed at a center of mass energy of $\sqrt{s} = 52.5$ GeV at the CERN-ISR with the Split-Field-Magnet (SFM) facility.

§ 2 DEFINITION OF EXPERIMENTAL QUANTITIES

To study the dynamics of the charge compensation process in large p_t reactions, we select a particle from one of the four jets and determine the "associated" (conditional) density of particle number and charge. These "associated" densities are obtained by selecting a particle h_2 from one of the four jets in a phase space interval around $\vec{p}_2$ and then evaluate the density of interest for the particles h_1 in the phase space interval around $\vec{p}_1$ for the rest of the event. The "associated particle density" is the density of particles of charge Q_1 at rapidity y_1, conditional to the observation of a particle at y_2 with the charge Q_2:

$$\rho^{Q_1Q_2}(y_1|y_2) = \frac{\rho^{Q_1Q_2}(y_1,y_2)}{\rho^{Q_2}(y_2)} \qquad (1)$$

ρ^{Q_1} and $\rho^{Q_1 Q_2}$ are the single-particle and two particle densities respectively.

The "associated net charge density" is given by

$$q(y_1|Q_2,y_2) = \rho^{+Q_2}(y_1|y_2) - \rho^{-Q_2}(y_1|y_2) \qquad (2)$$

To study the charge compensation, we use the "associated charge density balance"

$$\Delta q(y_1|y_2) = q(y_1|-,y_2) - q(y_1|+,y_2) \qquad (3)$$

i.e. the change of the "associated charge density" at y_1, when the charge at y_2 is changed from negative to positive. This quantity allows to select the charge density distribution of these particles, which compensate the charge of the selected particle h_2.[1)]

§ 3 EXPERIMENTAL RESULTS

1. "CHARGE DENSITY BALANCE" ASSOCIATED WITH THE TRIGGER PARTICLE

The "associated charge density balance" Δq is shown in fig.1 as a function of y_1 for the case that the trigger particle of the large p_t event istaken as the selected particle h_2. The data are compared with Δq as measured in nondiffractive inelastic events.[2,5)] Both distributions show a sharp peak in the rapidity interval of the selected particle and coincide in the peak region, which is a clear indication of a strong local component contributing to the charge compensation. Moreover an indication for a weaker global charge compensation component exists for the large p_t event.

To separate the contributions of the four jets to the charge compensation of the large p_t trigger particle at (y_T, p_T, ϕ_T), fig.2 shows the dependence of Δq on the rapidity y and the azimuthal angle ϕ of the additional particles for two event configurations. They differ by the rapidity of the "away jet", fixed in phase space by its leading particle. As the leading particle of the "away jet" we choose that particle in the "away region" ($\phi = \langle\phi_T\rangle + 180^o \pm 30^o$) with the highest transverse momentum, which has to exceed 0.6 GeV/c, in order to reduce the chance of misidentification. In the upper part of fig. 2 Δq is plotted for these configurations, where the "trigger jet" and the "away jet" are in the same y-interval ("back to antiback" configuration), while in the lower part of fig.2 the rapidity difference between the "trigger jet" and the "away jet" is large ("back to back" configuration).

For both event configurations a peak of Δq is observed in the azimuthal angular interval of the trigger particle ($\phi \approx \langle\phi_T\rangle$), whose position in y is independent of the rapidity of the "away jet". This result demonstrates that part of the trigger charge is compensated by low p_t particles of the "trigger jet" in agreement with observation of ref.4).

A peak of Δq in the azimuthal angular region opposite to the trigger particle ($\phi = \langle\phi_T\rangle + 180^o$) is also observed for both event configurations, but in contrast to the peak in the ϕ-interval of the trigger its position in rapidity follows that of the "away jet". This proves that part of the trigger charge is compensated by particles belonging to the "away jet". Since the charges of the leading particles in the "trigger jet" and in the "away jet" are uncorrelated [2,3], the observed charge flow between the "trigger jet" and the "away jet" is due to low p_t particles of the latter.

In addition to the two peaks of Δq already discussed, a flat contribution in ϕ shows up in fig.2, which is independent of y in a broad interval. This global component can be attributed to a charge flow between the "trigger jet" and the "spectator jets".

The observed three components contributing to the charge compensation of the trigger particle are in qualitative agreement with the expectations of the quark parton model [7]. From the investigation of the charge compensation of the leading particle in the "away jet" similar conclusions can be drawn as for the "trigger jet"[1].

2. "CHARGE DENSITY BALANCE" ASSOCIATED WITH A PARTICLE FROM THE "SPECTATOR JET"

To minimize the perturbation due to fragments from the "trigger jet" and the "away jet" in the study of the "spectator jet" fragmentation, only events have been analysed, where the "trigger jet" and the "away jet" are in a "back to antiback" configuration at $y < -0.7$. The selected particles of the "spectator jet" are localized at $y_2 > 0.5$.

For two intervals y_2 of the selected particle from the "spectator jet" Δq is plotted as function of y_1 in fig.3. The corresponding distributions for nondiffractive inelastic events, which have a selected particle in the same y_2 intervals, are included. The two distributions peak in the region of the selected particle and coincide in a wide rapidity region.

From this coincidence follows that for both event types the fragmentation of the corresponding parton is similar as far as charge compensation is concerned. In the case of the nondiffractive inelastic event it has been shown that a local compensation process dominates [2,5], which seems hold also for the "spectator jet" fragmentation. In addition the quark content of the two fragmenting systems is different [1,6],hence it follows from the present analysis that the adjustment of charges between the observed hadrons and the corresponding partons does not depend on the quark content of the fragmenting system.

§ 4 CONCLUSION

It is shown that local charge compensation dominates the fragmentation of the four jets of a large p_t event. The observed charge correlation length is the same as measured in nondiffractive inelastic events and in this sense is universal[8]. In addition a charge flow is observal between the different jets as expected in the framework of the quark parton model.

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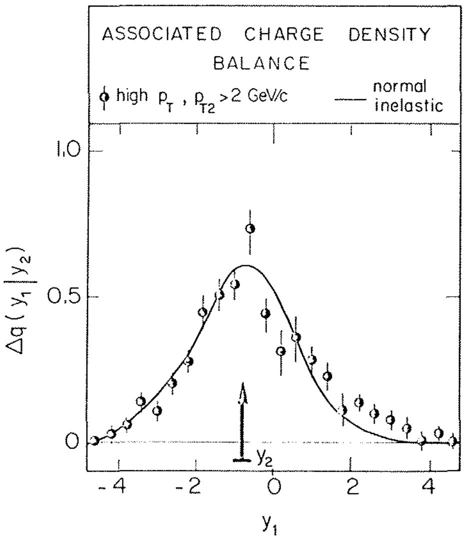

Fig. 1

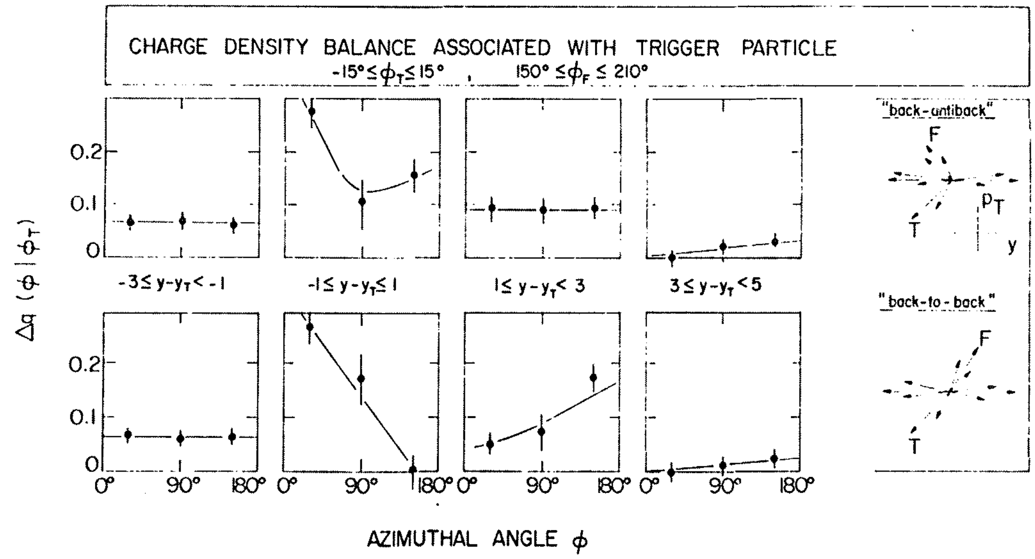

Fig. 2

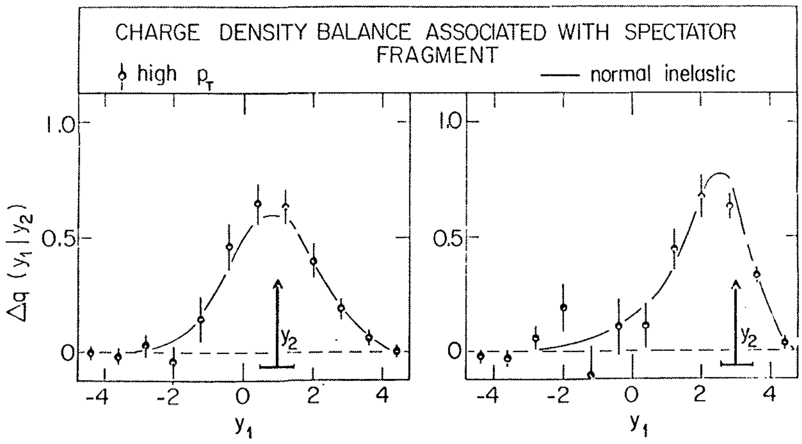

Fig. 3