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CHARGE ASYMMETRY AT LARGE P_T IN INELASTIC $\bar{P}P$ - REACTIONS AT 22.4 GEV/C

Alma-Ata - Dubna - Helsinki - Košice -
Moscow - Prague Collaboration

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Charge asymmetry at high transverse momenta has been earlier studied in high energy PP [1,2] and $\pi^{\pm}$ P collisions [3,4]. In this work we investigate charge asymmetry in $\bar{P}P$ interactions at 22.4 GeV/c from an experiment with "Ludmila" HBC at Serpukhov. We find that the charge asymmetries in the forward and backward centre-of-mass hemispheres increase with increasing transverse momentum.

This analysis is based on 11400 inelastic events which have been processed through the geometrical reconstruction programs: Mass Dependent THRESH or HYDRA Geometry. Experimental details have been discussed earlier [5,6].

In kinematical calculations secondary particles not identified by ionization were taken as pions. We have estimated the fraction of unidentified protons to be less than 5% of all positive secondaries. In fig. 1 we show the centre-of-mass rapidity distributions for positive and negative particles in the intervals $P_T < 0.5$ GeV/c and 1.0 GeV/c $< P_T <$ 1.5 GeV/c. The difference between the positive and negative particles, especially seen for $P_T < 0.5$ GeV/c, is mainly caused by the unidentified antiprotons assigned as pions. To avoid this effect,

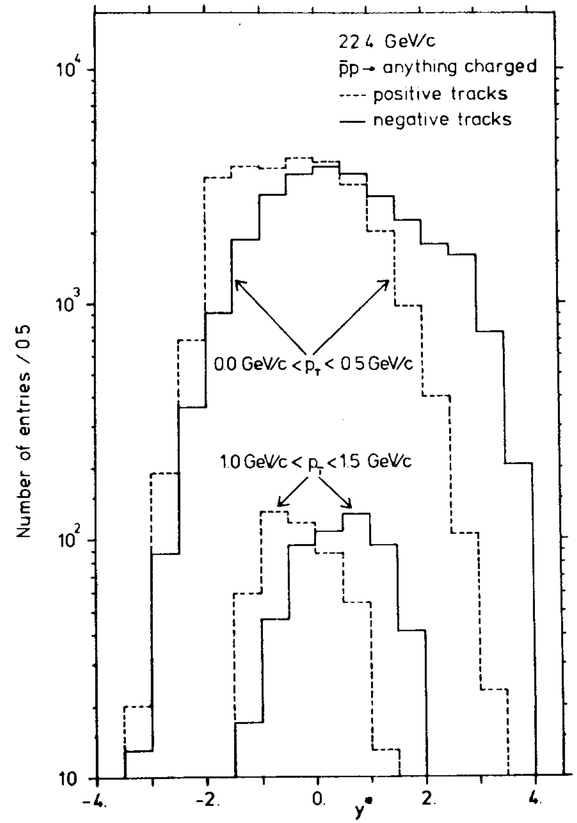

Fig. 1. Rapidity distributions for positive and negative secondaries in the two P_T intervals: $P_T < 0.5$ GeV/c and $1.0 < P_T <$ < 1.5 GeV/c.

we restrict our analysis to the region $|Y^*| < 1.$, where we still have unidentified protons. When labelling them as pions, we get a positive shift in rapidity, which, however, decreases with increasing transverse momentum. The shift is about one unit in rapidity for $P_T = 0.25$ GeV/c,

0.4 units for $P_T = 0.75$ GeV/c and 0.1 units for $P_T = 1.25$ GeV/c (see fig. 1.).

The charge asymmetry close to $Y^* = 0$ seems to be more pronounced for the high P_T tracks (1.0 GeV/c $< P_T <$ 1.5 GeV/c) than for the low P_T ones (fig. 1). We have tried several cuts in the relative error $\Delta P_T / P_T$ in order to see whether the measurement errors generate this increase of asymmetry. No significant difference among the resulting data samples was observed.

The average charge $\langle Q \rangle = (n_+ - n_-)/(n_+ + n_-)$ is shown in fig. 2 as a function of P_T for the two rapidity intervals $-1 < Y^* < 0$ and $0 < Y^* < 1$. For the backward hemisphere the average charge increases and for the forward one it decreases with increasing P_T. At low transverse momenta the average charge is seen to be distributed asymmetrically between the two hemispheres while at higher P_T symmetry around $\langle Q \rangle = 0$ is achieved. The excess of positive charge at small P_T is caused by the unidentified protons. Because of cp conservation n_+ can be substituted by n_-^{backw} in the expression for $\langle Q \rangle$ in the region $0 < Y^* < 1$ and by n_-^{forw} for $-1 < Y^* < 0$. This distribution (shown in fig. 2 for $0 < Y^* < 1$) is by definition symmetric around $\langle Q \rangle = 0$ and contains no biases due to unidentified protons. It shown (in the forward direction) the same decrease of the average charge as a function of P_T as observed above.

For comparison the average charge is plotted in fig. 3 as a function of normalized rapidity both for PP data at 24 GeV/c [7] and for $\pi^- P$ data at 205 GeV/c [3] for different P_T regions. For the sake of

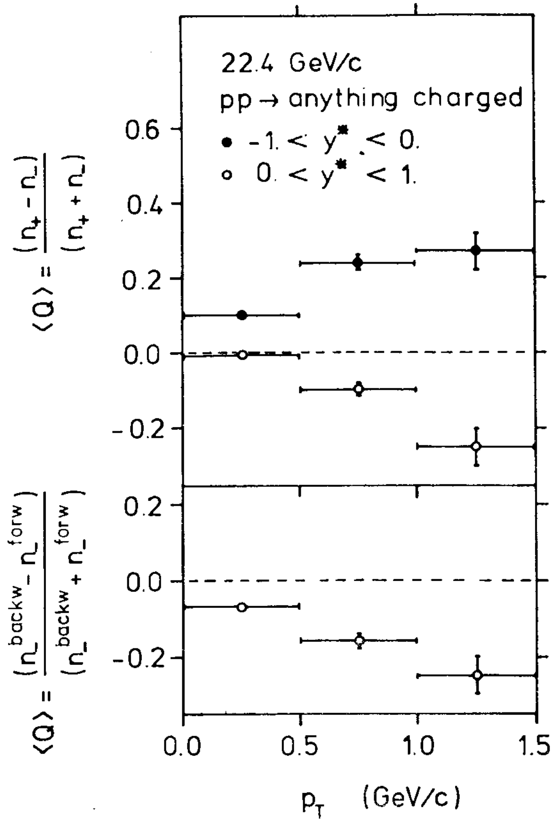

Fig. 2. Average charge as a function of transverse momentum in the forward and backward hemispheres for $|Y^*| < 1$.

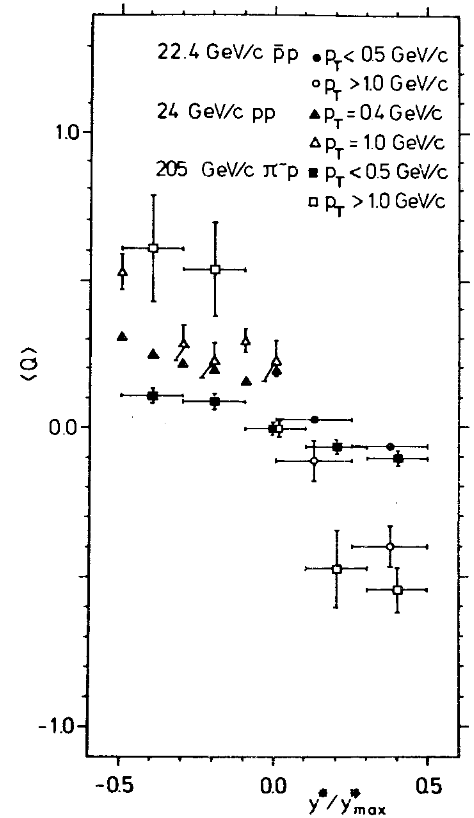

Fig. 3. Average charge as a function of normalized rapidity for different intervals in transverse momentum. The data of 24 GeV/c **PP** interactions /11/ and 205 GeV/c π^-**P** interactions /7/ are included. Our data are shown in the forward direction only.

clarity our data are shown only in the forward direction. We note that the difference between the $\langle Q \rangle$ distributions in the separate P_T regions is greater for our data than for the **PP** data, but smaller than for the π^-**P** data.

We have parametrized the increase of the asymmetry gap between the regions $-1 < Y^* < 0$ and $0 < Y^* < 1$ with the expression

$$\Delta \langle Q \rangle = a + b P_T \qquad (1)$$

for two different data samples: (a) events with an identified proton and (b) an "enriched" sample of annihilation events. The latter data sample consists of events with neither identified protons nor fast secondaries ($X > 0.66$), nor events with the total missing mass squared greater than 0.2 GeV^2. The parametrization of (1) gives for the slope b the value 0.34±0.12 for sample (a) and 0.63±0.16 for sample (b). Thus the charge asymmetry effect seems to be present both in the annihilation and the non-annihilation channels and increases in a similar way with increasing P_T. By investigating the asymmetry gap as a function of charged multiplicity, we have found that the gap increases with P_T in all topologies.

The average charged multiplicity for events with a high P_T track ($P_T > 1$ GeV/c) is $\langle n_{ch} \rangle = 5.6 \pm 0.3$, a value lying substantially higher than the $\langle n_{ch} \rangle$ for all charged secondaries ($\langle n_{ch} \rangle = 4.69 \pm 0.05$ [5]). The percentage of high P_T tracks out of all produced tracks is almost independent of the final state multiplicity, the average value being (1.75±0.05)%.

We conclude that the average charge is asymmetrically distributed in the forward and backward directions close to $Y^* = 0$ and the asymmetry increases with increasing transverse momentum, thus confirming the results of ref. [3]. The increase of the asymmetry gap as a function of P_T is larger in our 22.4 GeV/c data than in PP data at almost the same incident energy, but smaller than in $\pi^- P$ data at 205 GeV/c. The charge asymmetry phenomenon has been

recently explained [8] for the $\pi^- P$ results by the parton model considering jet production in valence quark-antiquark scattering. This picture leads to larger asymmetry in $\bar{P}P$ reactions than in PP or πP reactions at the same incident energy.

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