PRELIMINARY RESULTS ON SINGLE SPIN ASYMMETRY MEASUREMENTS IN INCLUSIVE p↑p REACTIONS AT HIGH P⊥ AND 16.5 GeV/c

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JOURNAL DE PHYSIQUE
Colloque C2, supplément au n°2, Tome 46, février 1985

PRELIMINARY RESULTS ON SINGLE SPIN ASYMMETRY MEASUREMENTS IN INCLUSIVE P↑P REACTIONS AT HIGH $P_\perp$ AND 16.5 GeV/c*

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Résumé - Nous présentons des résultats préliminaires sur les asymétries dans la production inclusive de pions, kaons et protons avec un faisceau polarisé de 16,5 GeV/c sur une cible d'hydrogène non polarisée. Ces données couvrent des moments transverses entre 1,0 et 2,7 GeV/c et x_F voisin de zéro.

Abstract - Preliminary results are presented on the scattering asymmetries of pions, kaons, and protons produced inclusively from a 16.5 GeV/c polarized proton beam incident on an unpolarized hydrogen target. The data are for transverse momenta between 1.0 and 2.7 GeV/c and X_F near zero.

Since inclusive reactions sum over many channels, common folklore has held that any spin dependence should be small. Experiments on inclusive hyperon production show considerable Λ polarization at quite a range of energies KEK, AGS, FNAL, ISR (see K. Heller's article in these proceedings). This polarization increases with X_F and exhibits a relatively low $p_\perp$ dependence above $p_\perp$ of 1.0 GeV/c. Inclusive production of pions and kaons at ANL[1,2] showed large asymmetries that increase with X_F and $p_\perp$ but the bulk of the data is at $p_\perp < 1$ GeV/c.

In the hard scattering domain (large $p_\perp$) inclusive measurements can provide information on the direct interactions between the hadron constituents. Inclusive production is seen in perturbative QCD as arising from a single interaction between two constituents of the hadrons. An asymmetry can be generated only by a sizeable spin flip amplitude in this quark-quark interaction. These amplitudes are expected[3] to be suppressed by a factor $m_q/\sqrt{s}$. If we use an asymptotic quark mass of 5 MeV and $\sqrt{s}$ = 5.6 GeV, helicity flip amplitudes for our experiment are suppressed by a factor of 10^{-3}, thus anticipated asymmetries would be small or zero. In fact, the hyperon asymmetries are not small even at $p_\perp$ = 4 GeV/c, and they do not become smaller as the energy is increased (again, one expects an $m_q/\sqrt{s}$ dependence). This is not understood, and it is clearly interesting to see whether there are other violations of this perturbative QCD rule.[4]

Experiments at large $p_\perp$ are rare and we cite two examples: an ANL[5] measurement of π^- asymmetries up to $p_\perp$ of 1.2 GeV/c sees effects of less than 10%, and the other is π° production at 24 GeV/c where large asymmetries were observed at $p_\perp$ of 2.0 GeV/c,[6] albeit with large error bars.

Our experiment uses the new AGS polarized proton beam that was commissioned in July 1984 in a mode that interleaved between machine research and high energy physics.

*Work performed under the auspices of the U.S. Department of Energy

The experimental layout is shown in Fig. 1. A primary 16.5 GeV/c polarized proton beam ($\Delta p/p < 0.5\%$) was transported down the C1 line at an intensity of 10^8 protons/pulse. The beam intensity was monitored by an ion chamber, an integrated scintillator counter, and a large angle beam telescope. The polarization was determined by several polarimeters. A polarimeter internal to the AGS measured the polarization once per shift, a local polarimeter monitored the relative polarization via small angle elastic scattering from our target, and two polarimeters in another external beam line. Our local polarimeter gave a 3σ mesurement of the pp elastic asymmetry per hour. The average beam polarization was relatively low (25-30%) and the other beam line polarimeters developed some problems during a good portion of the run. We relied on the local polarimeter to select the data included in this sample.

A single arm spectrometer utilizing proportional and drift wire chambers measured the momentum of the scattered tracks with a resolution of 1/2%. Two trigger matrices, one using two vertical hodoscopes and a second using the drift chamber hits selected the events within the proper $p_\perp$ and p windows. Particle identification was determined by two freon filled Cerenkov counters of threshold $\gamma = 21.5$ and 9.5 respectively. Data for positive and negative particles were collected separately by reversing the polarity of the analyzing magnet.

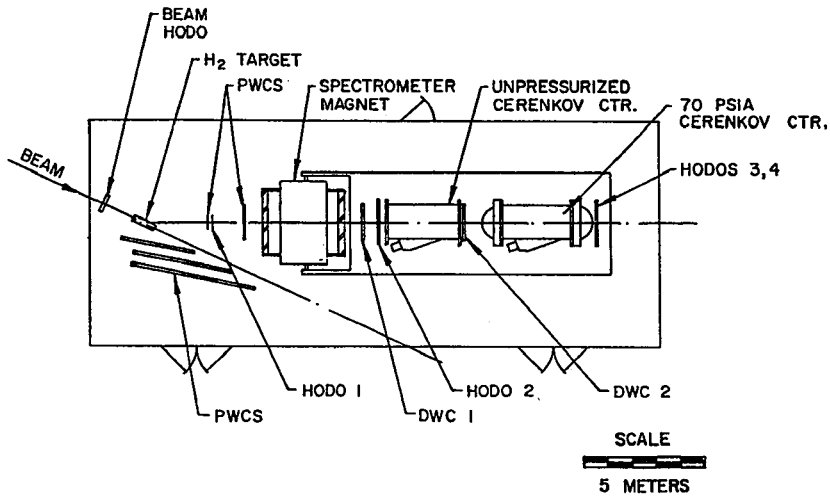

Fig. 1. Layout of the experimental setup.

Figure 2 shows the inclusive production rate of various particles relative to protons. The spectra are compared to data from K. Raychaudhuri et al[6] that measured these inclusive spectra at 20 GeV/c and a similar kinematic region. The data follow the general trend for $1.0 < p_\perp < 2.2$ GeV/c. The lower limit represents our trigger cut-off and above 2.2 there is no data to compare with; however, it is interesting to note that a democracy in production prevails that could be indicative of hard scattering. Individual runs were normalized to the relative beam intensities for spins up and down respectively. The raw asymmetry was calcuated as $A = \frac{N\uparrow - N\downarrow}{N\uparrow + N\downarrow}$ and $\delta A = \frac{1}{\sqrt{N\uparrow + N\downarrow}}$ where $N\uparrow$ and $N\downarrow$ are the normalized number of scatters of each species for beam polarizations up and down respectively. The normalization was of the order of a few percent for each run, but averaged over all the data it amounted to less than a tenth of 1%. All systematics and geometrical considerations cancel out with the polarization reversal on alternate beam pulses.

The raw π^+ and π^- asymmetries are shown in Fig. 3 (a,b) and Fig. 3c shows the π^- data from ANL near X=0. The asymmetries are low over the full $p_\perp$ range up to the kinematic limit. The statistics do not allow any inference but there seem to be two opposite trends in π^+ and π^- and if the π^- data were scaled to full beam polarization of 100% it is consistent with ANL data at 12 GeV/c and $p_\perp$ of 1 GeV/c.

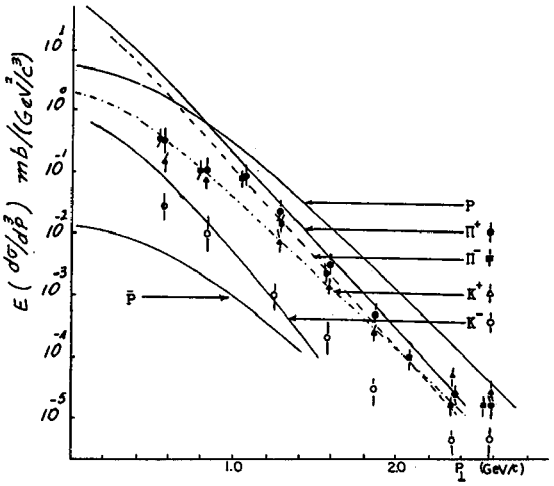

Fig. 2. Particle production spectra at 16.5 GeV/c compared to the parametrization of the 20 GeV/c data of Ref. 7. Our proton production is assumed to be the same and the ratios are plotted vs. $P_\perp$.

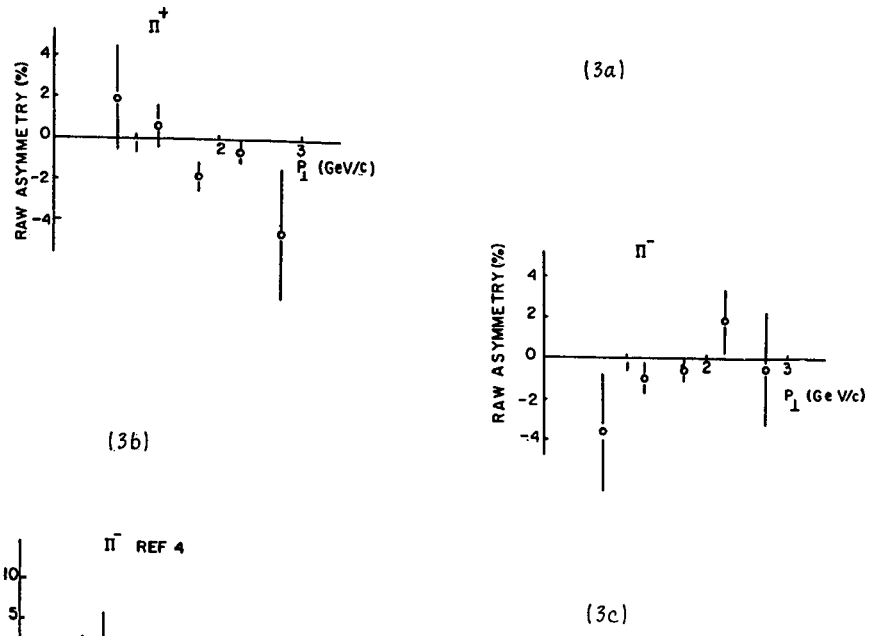

Fig. 3. Raw asymmetries vs. $P_\perp$ for inclusively produced π^+ (3a), π^- (3b) and the π^- asymmetry data corrected for 100% beam polarization from ref. 5 taken at 12 GeV/c.

The $K^{\pm}$ data are shown in Figure 4(a,b) and the proton data (4c). Again, no strikingly large asymmetries are seen. We note that in all of the data there is a suggestion of a break or some structure at $P_{\perp}$ of 2.2 GeV/c which is the region where a sharp rise in A_n in pp elastic scattering seems to occur.[8]

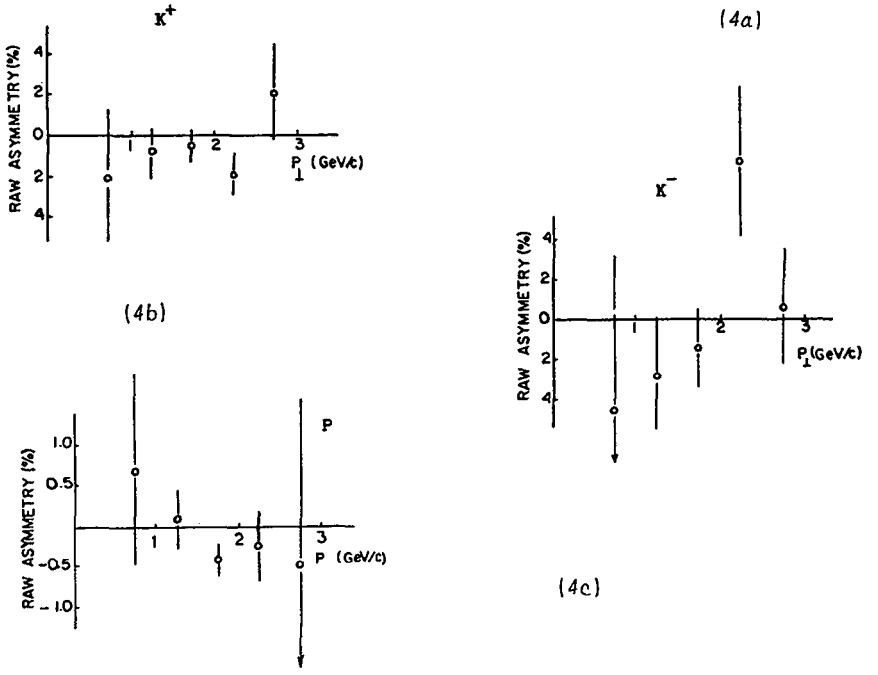

Fig. 4. Raw asymmetries vs. $p_{\perp}$ in inclusive production of K^{+}(4a), K^{-}(4b), and p(4c).

For comparison we show the data of Antille et al.[6], Fig. 5, on the asymmetry in π° production at high $p_{\perp}$ and X=0. Our low asymmetries in $\pi^{\pm}$ production are certainly in disagreement with the π° data for the same $P_{\perp}$ range. It could be postulated that the production mechanisms are different or that an energy threshold is responsible for the difference. We have not scaled our data to full beam polarization at this stage due to the uncertainty on our part of the assessment of the absolute beam polarization.

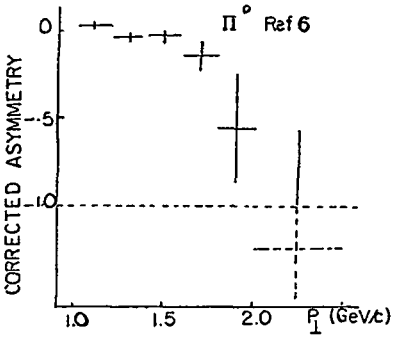

Fig. 5. Asymmetry in inclusive π° production at 24 GeV/c (Ref. 6). The data was corrected for the dilution factor of π° produced in the target vs. $P_{\perp}$.

The experimenters plan to continue data taking, at higher beam polarization, next year where it is hoped that 3-4 times the number of events will be accumulated. We also have data on inclusive Λ production. From the Λ decay asymmetry we will study the spin transfer from the beam to the produced Λ.

Acknowledgements

We would like to thank the staff of the AGS Department at BNL for their assistance and especially J. Mills, D. Dayton, and R. Meier who helped prepare the apparatus for this run. Our thanks to R. Dlhopolsky and S. Kaplan for their help in running the experiment.

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8. See A.D. Krisch (proceedings of this conference) and the R. Raymond presentation in the Workshop on Experiment and Theory in Spin Effect at High Energies.