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PRELIMINARY MEASUREMENT OF D^*/D PRODUCTION AND D^* SPIN ALIGNMENT AT THE Z^0 RESONANCE*

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Abstract

Using hadronic Z^0 decays recorded by the SLD experiment at SLAC, we have measured the vector/ (vector+pseudoscalar) production ratio, *V/(V + P)*, for the prompt charmed mesons, D^{*+} and D^+ Using the channels $D^{*+} \to D^0 \pi_s^+$, $D^0 \to K^- \pi^+$, and $D^0 \to K^- \pi^+ \pi^- \pi^+$, as well as $D^+ \to K^- \pi^+ \pi^-$, we find $V/(V+P) = 0.61 \pm 0.09(stat.) \pm 0.03(BR)$, which disfavors the expectation of 0.75 from naive spin-counting. We have also measured the degree of D^{*+} spin alignment along the flight direction and find it to be consistent with zero for D^{*+} fractional momenta $x \equiv E_{D^*}/E_{beam} > 0.2$. We compare these results with QCD model predictions,

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1 Introduction

We present the preliminary results of a study of the production of charmed vector and pseudoscalar mesons in Z^0 decay events produced by the SLAC Linear Collider (SLC) and recorded by the SLC Large Detector (SLD) experiment [1]. The charmed mesons are tagged via the channels of $D^{*+} \to D^0 \pi_s^+$ followed by $D^0 \to K^- \pi^+ (K\pi$ mode) or $D^0 \to K^- \pi^+ \pi^- \pi^+ (K\pi\pi\pi$ mode), and $D^+ \to K^- \pi^+ \pi^-$ By comparing the number of D^{*+} and D^+ mesons found *, we measured P_V as a function of $x_D = 2E_D/\sqrt{s}$, where $\sqrt{s}$ is the c.m. energy. We also measured the degree of D^{*+} spin alignment and its dependence on x_D. This represents the first study of D^{*+} spin alignment in Z^0 decays.

2 Measurement of P_V

Tagged D mesons are mixture of $c\bar{c}$ and $b\bar{b}$ events. The $c\bar{c}$ contribution to the D mesons is extracted by subtracting $b\bar{b}$ contribution which is estimated by a two dimensional impact parameter technique. The measured numbers of D^{*+} and D^+ mesons in $c\bar{c}$ events [2], $N_{c\to D^{*+}}$ and $N_{c\to D^+}$ respectively, are related to the quantity P_V via:

$$\frac{N_{c\to D^{*+}}}{N_{c\to D^+}} \cdot \frac{Br_+}{Br_0} = \frac{P_V Br_*}{1 - P_V Br_*} \ , \tag{1}$$

where Br_* = 68.1 $\pm$ 1.0 $\pm 1.3\%$ [3] is the branching fraction for $D^{*+} \to D^0 \pi_s^+$, Br_0 = 3.84 $\pm$ 0.13%, $7.50 \pm$ 0.4% and Br_+ = 9.1 $\pm 0.6\%$ [4] are the branching fractions for $D^0 \to K^- \pi^+$, $D^0 \to K^- \pi^+ \pi^- \pi^+$, and $D^+ \to K^- \pi^+ \pi^-$ We considered separately the number of D^{*+} formed from each D^0 decay mode and solved equation (1) in each bin of x_D. We obtained results for P_V shown in Figure 1. Averaging over the region $x_D > 0.4$, we obtain $P_V = 0.678 \pm 0.095$ for the $K\pi$ mode and $P_V = 0.519 \pm 0.116$ for the $K\pi\pi\pi$ mode, where the errors are the sum in quadrature of the statistical errors and the branching fraction errors. The results are consistent within the errors so we averaged them to obtain P_V = 0.607 $\pm 0.087(stat.) \pm 0.029(BR)$ (PRELIMINARY). This result is not consistent with the naive spin-counting expectation of P_V =0.75, but is in agreement with previous measurements from LEP experiments [5] [6]. These results can also be compared with QCD calculations. P_V as a function of x_D is shown in Figure 1, together with the predictions of Braaten, Cheung and Yuan [8] and Suzuki [7]. The predictions are consistent with the data within errors.

*** Charge-conjugate are implied unless stated otherwise.**

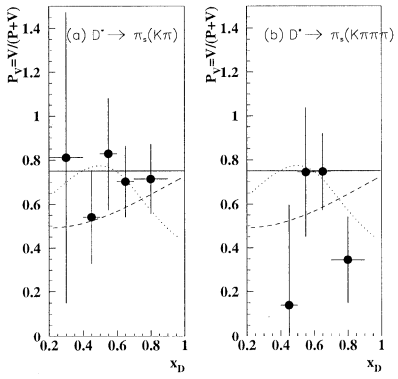

Figure 1: P_V as a function of x_D for (a) $K\pi$ and (b) $K\pi\pi\pi$ modes. The solid line represents the expectation of naive spin counting, the dotted line is the calculation by Suzuki, and the dashed line is the calculation by Braaten, Cheung and Yuan

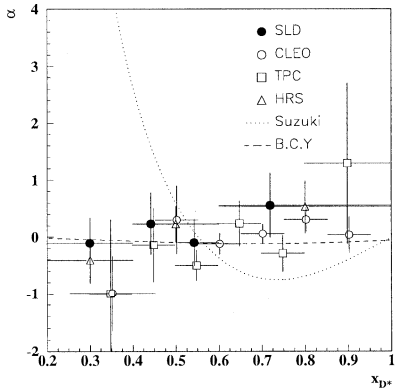

Figure 2: Fitted α as a function of x_{D^*} together with CLEO, HRS, and TPC data from lower $c.m.$ energies. Model calculations are also shown (see text).

3 Measurement of D^{*+} spin alignment

We measured the degree of D^{*+} spin alignment along the flight direction by considering the angle θ^* between the momentum direction of the D^{*+} in the laboratory frame and the D^0 in the D^{*+} rest frame. We fitted the function:

$$\frac{1}{N}\frac{dN}{dcos\theta^*} = \frac{3}{(6+2\alpha)}[1+\alpha cos^2\theta^*], \tag{2}$$

to angular distributions of $cos\theta^*$ for D^{*+} candidates after statistical subtraction of random combinatorics background (RCBG). The RCBG contribution was estimated using the Monte Carlo events normalized by the numbers of background events from the data. The fitted α, for each x_{D^*} bin are shown in Figure 2. These results are consistent with previous' measurements from CLEO [9], HRS [10], and TPC [11] at lower *c.m.* energies. QCD calculations by Suzuki [7] and, by Braaten, Cheung and Yuan [8] are also shown in Figure 2. Suzuki's calculation is disfavored by the data.

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