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Measurement of Collins asymmetries at BaBar

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Summary. — Inclusive hadron production cross sections and angular distributions in e^+e^- collisions shed light on fundamental questions of hadronization and fragmentation processes. We present measurements of the so-called Collins azimuthal asymmetries in inclusive production of hadron pairs in $e^+e^- \to h_1 h_2 X$ annihilation process, where the two hadrons (either kaons or pions) are produced in opposite hemispheres. In particular, this is the first measurement in e^+e^- annihilation experiment of the KK and $K\pi$ azimuthal asymmetries, which allow to better understand the fragmentation processes and the role of the strage quark, and can be used as a tool to explore the spin content of the nucleon.

Transverse spin effects in fragmentation processes were fist discussed by Collins in ref. [1], who introduced the so called Collins function $H_1^\perp$, a chiral-odd polarized fragmentation function used to describe the final state hadron's distributions around the momentum of the fragmenting quark. Collins effect can be accessed in e^+e^- annihilation experiments by studying the process $e^+e^- \to h_1 h_2 X$, where two charged hadrons, either pions or kaons, are detected in opposite jets. Detailed studies were performed for pion pairs by Belle [2] and BaBar [3] Collaborations, and a clear non zero Collins effect is observed as a function of several kinematic variables.

In this report, we present the first measurement of Collins effect for kaons in e^+e^- annihilation experiment using BaBar data: the analysis is based on a total integrated luminosity of $468\,\text{fb}^{-1}$ collected at the center-of-mass energy of about 10.6 GeV. In particular, we measure the azimuthal modulation for charged KK and $K\pi$ pairs as a function of hadron fractional energies (z_1, z_2), which is proportional to the product (or convolution) of two $H_1^\perp$. In addition, we simultaneously extract the asymmetries for $\pi\pi$ pairs, which are found to be in good agreement with the measurements in ref. [3].

The Collins effect, or Collins asymmetry, can be accessed by measuring the $\cos\phi$ modulations of the normalized distributions of selected hadron pairs in two different reference frames, called RF12 and RF0. Detector effects can be reduced by constructing the ratio of the azimuthal distributions for hadron pairs with opposite charge U over same charge L (or over $C = U + L$). Azimuthal modulations are calculated simultaneously for KK, $K\pi$, and $\pi\pi$ pairs. The measured asymmetries are corrected for the background

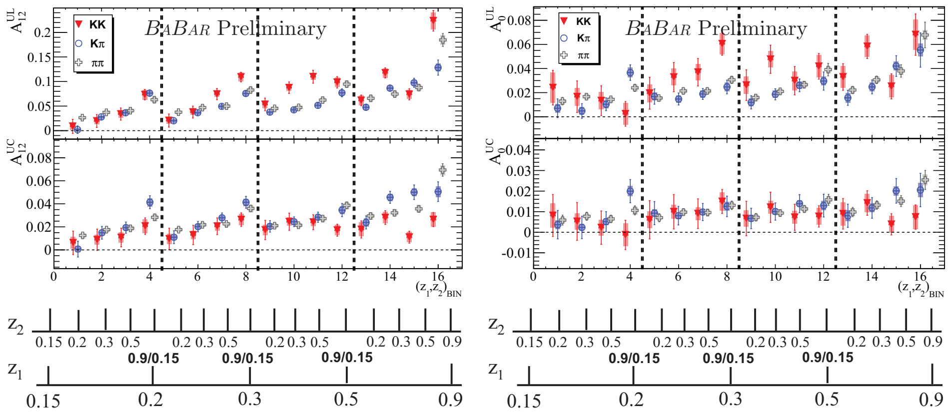

Fig. 1. – Comparison of A^{UL} (top) and A^{UC} (bottom) Collins asymmetries in RF12 (left) and RF0 (right) for KK, $K\pi$, and $\pi\pi$ pairs. The statistical and systematic uncertainties are represented by the bars and the bands around the points, respectively. The 16 (z_1, z_2) bins are shown on the x-axis: in each interval between the dashed lines, z_1 is chosen in the following ranges: $[0.15, 0.2]$, $[0.2, 0.3]$, $[0.3, 0.5]$, and $[0.5, 0.9]$, while within each interval the points correspond to the four bins in z_2.

contributions, mainly coming from charm events, for the K/π contamination, for the small asymmetry values measured in the MC samples, and for the dilution effect due to the thrust axis approximation as the true $q\bar{q}$ axis. More detail can be found in ref. [4].

The results are summarized in fig. 1. We measure nonzero asymmetries, which increase as a function of the hadron energies in both reference frames. The largest effect is observed for KK pairs. These results are in partial agreement with the prediction reported in ref. [5], which estimates a bigger effect for kaons, about twice as big the Collins effect for pions. These measurements, combined with semi-inclusive deep inelastic scattering data, allow to extract the strange-quark contribution to the nucleon's spin, and to improve the knowledge of the fragmentation processes.

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