CLNS 03/1823
CLEO 03-07

Measurement of the Charge Asymmetry in $B \to K^*(892)^\pm \pi^\mp$

B. I. Eisenstein,[1] G. D. Gollin,[1] I. Karliner,[1] N. Lowrey,[1] C. Plager,[1] C. Sedlack,[1] M. Selen,[1] J. J. Thaler,[1] J. Williams,[1] K. W. Edwards,[2] D. Besson,[3] S. Anderson,[4] V. V. Frolov,[4] D. T. Gong,[4] Y. Kubota,[4] S. Z. Li,[4] R. Poling,[4] A. Smith,[4] C. J. Stepaniak,[4] J. Urheim,[4] Z. Metreveli,[5] K.K. Seth,[5] A. Tomaradze,[5] P. Zweber,[5] S. Ahmed,[6] M. S. Alam,[6] J. Ernst,[6] L. Jian,[6] M. Saleem,[6] F. Wappler,[6] K. Arms,[7] E. Eckhart,[7] K. K. Gan,[7] C. Gwon,[7] K. Honscheid,[7] H. Kagan,[7] R. Kass,[7] T. K. Pedlar,[7] E. von Toerne,[7] H. Severini,[8] P. Skubic,[8] S.A. Dytman,[9] J.A. Mueller,[9] S. Nam,[9] V. Savinov,[9] J. W. Hinson,[10] G. S. Huang,[10] J. Lee,[10] D. H. Miller,[10] V. Pavlunin,[10] B. Sanghi,[10] E. I. Shibata,[10] I. P. J. Shipsey,[10] D. Cronin-Hennessy,[11] C. S. Park,[11] W. Park,[11] J. B. Thayer,[11] E. H. Thorndike,[11] T. E. Coan,[12] Y. S. Gao,[12] F. Liu,[12] R. Stroynowski,[12] M. Artuso,[13] C. Boulahouache,[13] S. Blusk,[13] E. Dambasuren,[13] O. Dorjkhaidav,[13] R. Mountain,[13] H. Muramatsu,[13] R. Nandakumar,[13] T. Skwarnicki,[13] S. Stone,[13] J.C. Wang,[13] A. H. Mahmood,[14] S. E. Csorna,[15] I. Danko,[15] G. Bonvicini,[16] D. Cinabro,[16] M. Dubrovin,[16] S. McGee,[16] A. Bornheim,[17] E. Lipeles,[17] S. P. Pappas,[17] A. Shapiro,[17] W. M. Sun,[17] A. J. Weinstein,[17] R. A. Briere,[18] G. P. Chen,[18] T. Ferguson,[18] G. Tatishvili,[18] H. Vogel,[18] M. E. Watkins,[18] N. E. Adam,[19] J. P. Alexander,[19] K. Berkelman,[19] V. Boisvert,[19] D. G. Cassel,[19] J. E. Duboscq,[19] K. M. Ecklund,[19] R. Ehrlich,[19] R. S. Galik,[19] L. Gibbons,[19] B. Gittelman,[19] S. W. Gray,[19] D. L. Hartill,[19] B. K. Heltsley,[19] L. Hsu,[19] C. D. Jones,[19] J. Kandaswamy,[19] D. L. Kreinick,[19] A. Magerkurth,[19] H. Mahlke-Krüger,[19] T. O. Meyer,[19] N. B. Mistry,[19] J. R. Patterson,[19] D. Peterson,[19] J. Pivarski,[19] S. J. Richichi,[19] D. Riley,[19] A. J. Sadoff,[19] H. Schwarthoff,[19] M. R. Shepherd,[19] J. G. Thayer,[19] D. Urner,[19] T. Wilksen,[19] A. Warburton,[19,*] M. Weinberger,[19] S. B. Athar,[20] P. Avery,[20] L. Breva-Newell,[20] V. Potlia,[20] H. Stoeck,[20] and J. Yelton[20]

(CLEO Collaboration)

[1]*University of Illinois, Urbana-Champaign, Illinois 61801*
[2]*Carleton University, Ottawa, Ontario, Canada K1S 5B6*
and the Institute of Particle Physics, Canada
[3]*University of Kansas, Lawrence, Kansas 66045*
[4]*University of Minnesota, Minneapolis, Minnesota 55455*
[5]*Northwestern University, Evanston, Illinois 60208*
[6]*State University of New York at Albany, Albany, New York 12222*
[7]*Ohio State University, Columbus, Ohio 43210*
[8]*University of Oklahoma, Norman, Oklahoma 73019*
[9]*University of Pittsburgh, Pittsburgh, Pennsylvania 15260*
[10]*Purdue University, West Lafayette, Indiana 47907*
[11]*University of Rochester, Rochester, New York 14627*
[12]*Southern Methodist University, Dallas, Texas 75275*
[13]*Syracuse University, Syracuse, New York 13244*
[14]*University of Texas - Pan American, Edinburg, Texas 78539*
[15]*Vanderbilt University, Nashville, Tennessee 37235*
[16]*Wayne State University, Detroit, Michigan 48202*
[17]*California Institute of Technology, Pasadena, California 91125*

[18] *Carnegie Mellon University, Pittsburgh, Pennsylvania 15213*
[19] *Cornell University, Ithaca, New York 14853*
[20] *University of Florida, Gainesville, Florida 32611*
(Dated: April 22, 2003)

Abstract

We report on a search for a CP-violating asymmetry in the charmless hadronic decay $B \to K^*(892)^\pm \pi^\mp$, using 9.12 fb^{-1} of integrated luminosity produced at $\sqrt{s} = 10.58$ GeV and collected with the CLEO detector. We find $\mathcal{A}_{CP}(B \to K^*(892)^\pm \pi^\mp) = 0.26^{+0.33}_{-0.34}(\text{stat.})^{+0.10}_{-0.08}(\text{syst.})$, giving an allowed interval of $[-0.31, 0.78]$ at the 90% confidence level.

*Present address: McGill University, Montréal, Québec, Canada H3A 2T8

The Standard Model predicts that CP-violating phenomena are governed solely by the single imaginary parameter of the Cabibbo-Kobayashi-Maskawa matrix [1] of complex quark couplings. The first observations of CP violation in the neutral B system were recently reported [2], and they have been interpreted widely as induced by B^0-$\bar{B}^0$ mixing. To date, direct CP violation has only been observed in the neutral kaon system [3]. Direct CP violation in a given decay requires contributions from two or more amplitudes which differ in both CP-violating (weak) and CP-conserving (strong) phases. In the B system, these conditions are expected to be met in some charmless hadronic decays, and direct CP violation can occur at sizeable levels, depending on the magnitude of the strong phase difference [4, 5] or on the presence of new physics [6]. Previous analyses, mainly focusing on two-pseudoscalar final states, have not observed direct CP violation in these decays [7, 8]. In this Report, we present a search for direct CP violation in the vector-pseudoscalar decay $B \to K^*(892)^{\pm}\pi^{\mp}$. We express the difference between the decay rates for $\bar{B}^0 \to K^*(892)^-\pi^+$ and $B^0 \to K^*(892)^+\pi^-$ in terms of an asymmetry, $\mathcal{A}_{CP}$, defined as

$$\mathcal{A}_{CP} \equiv \frac{\mathcal{B}(\bar{B}^0 \to K^*(892)^-\pi^+) - \mathcal{B}(B^0 \to K^*(892)^+\pi^-)}{\mathcal{B}(\bar{B}^0 \to K^*(892)^-\pi^+) + \mathcal{B}(B^0 \to K^*(892)^+\pi^-)}. \tag{1}$$

We consider both $K^*(892)^{\pm}$ submodes, $K^*(892)^{\pm} \to K^0_S\pi^{\pm}$ and $K^*(892)^{\pm} \to K^{\pm}\pi^0$ by analyzing the final states $K^0_S\pi^{\pm}h^{\mp}$ and $K^{\pm}h^{\mp}\pi^0$, where $h^{\mp}$ denotes a charged pion or kaon. We perform a maximum likelihood fit in the $K^0_S\pi^{\pm}h^{\mp}$ and $K^{\pm}h^{\mp}\pi^0$ Dalitz plots to distinguish $B \to K^*(892)^{\pm}\pi^{\mp}$ from other intermediate resonances or non-resonant three-body decays. The CP-averaged branching fraction for $B \to K^*(892)^{\pm}\pi^{\mp}$ has been measured by the Belle [9] and CLEO [10] Collaborations, and the work described in this Report is an extension of that previous CLEO analysis.

The data sample used in this analysis was produced in symmetric e^+e^- collisions at the Cornell Electron Storage Ring (CESR) and collected with the CLEO detector in two configurations, known as CLEO II [11] and CLEO II.V [12]. It comprises 9.1 fb^{-1} of integrated luminosity collected on the $\Upsilon(4S)$ resonance, corresponding to 9.7×10^6 $B\bar{B}$ pairs, of which 6.3×10^6 were taken with CLEO II.V. An additional 4.4 fb^{-1} collected below the $B\bar{B}$ production threshold is used to study non-$B\bar{B}$ backgrounds. Of this latter luminosity, 2.8 fb^{-1} were collected with CLEO II.V. The response of the experimental apparatus is studied with a detailed GEANT-based [13] simulation of the CLEO detector, where the simulated events are processed in a fashion similar to data.

In CLEO II, the momenta of charged particles are measured with a tracking system consisting of a six-layer straw tube chamber, a ten-layer precision drift chamber, and a 51-layer main drift chamber, all operating inside a 1.5 T superconducting solenoid. The main drift chamber also provides a measurement of specific ionization energy loss (dE/dx), which is used for particle identification. For CLEO II.V, the six-layer straw tube chamber was replaced by a three-layer double-sided silicon vertex detector, and the gas in the main drift chamber was changed from an argon-ethane to a helium-propane mixture. Photons are detected with a 7800-crystal CsI electromagnetic calorimeter, which is also inside the solenoid. Proportional chambers placed at various depths within the steel return yoke of the magnet identify muons.

Charged tracks are required to be well-measured and to satisfy criteria based on the track fit quality. They must also be consistent with coming from the interaction point in three dimensions. Pions and kaons are identified by consistency with the expected dE/dx, and tracks that are positively identified as electrons or muons are not allowed to form the

B candidate. We form π^0 candidates from pairs of photons with invariant mass within 20 MeV/c^2 (approximately 2.5 standard deviations (σ)) of the known π^0 mass. These candidates are then kinematically fitted with their masses constrained to the known π^0 mass. We also require the π^0 momentum to be greater than 1 GeV/c to reduce combinatoric background from low-momentum π^0 candidates. K_S^0 candidates are selected from pairs of tracks with invariant mass within 10 MeV/c^2 or 2.5σ of the known K_S^0 mass. In addition, K_S^0 candidates are required to originate from the beam spot and to have well-measured displaced decay vertices.

We identify B meson candidates by their invariant mass and the total energy of their decay products. We calculate a beam-constrained mass by substituting the beam energy (E_b) for the measured B candidate energy: $M \equiv \sqrt{E_b^2 - \mathbf{p}_B^2}$, where $\mathbf{p}_B$ is the B candidate momentum. Performing this substitution improves the resolution of M by one order of magnitude, to about 3 MeV/c^2. We define $\Delta E \equiv E_1 + E_2 + E_3 - E_b$, where E_1, E_2, and E_3 are the energies of the B candidate daughters. For final states with a K_S^0 and two charged tracks, the ΔE resolution is about 20 MeV for CLEO II and 15 MeV for CLEO II.V. A π^0 in the final state degrades this resolution by approximately a factor of two. ΔE is always calculated assuming the $h^\mp$ is a pion. Therefore, the ΔE distribution for pions is centered at zero, while that for kaons is shifted by at least -40 MeV. We accept B candidates with M between 5.2 and 5.3 GeV/c^2 and with $|\Delta E|$ less than 300 MeV for $K^\pm h^\mp \pi^0$ and 200 MeV for $K_S^0\pi^\pm h^\mp$. This region includes the signal region and a high-statistics sideband for background normalization. We reject candidates that are consistent with the exclusive $b \to c$ transitions $B \to D\pi$, where $D \to K\pi$, and $B \to \psi K^0$, where $\psi \to \mu^+\mu^-$ and the muons are misidentified as pions.

The main background in this analysis arises from $e^+e^- \to q\bar{q}$, where $q = u, d, s, c$. To suppress this background, we calculate the angle $\theta_{\rm sph}$ between the sphericity axis [14] of the tracks and showers forming the B candidate and that of the remainder of the event. Because of their two-jet structure, continuum $q\bar{q}$ events peak strongly at $|\cos\theta_{\rm sph}| = 1$, while the more isotropic $B\bar{B}$ events are nearly flat in this variable. By requiring $|\cos\theta_{\rm sph}| < 0.8$, we reject 83% of the continuum background while retaining 83% of signal B decays. Additional separation of signal from $q\bar{q}$ background is provided by a Fisher discriminant [15] $\mathcal{F}$ formed from eleven variables: the angle between the sphericity axis of the candidate and the beam axis, the ratio of Fox-Wolfram moments H_2/H_0 [16], and the scalar sum of the visible momentum in nine 10° angular bins around the candidate sphericity axis. In the likelihood fit, we also make use of the angle between the B candidate momentum and the beam axis, θ_B. Angular momentum conservation causes B mesons produced through the $\Upsilon(4S)$ to exhibit a $\sin^2\theta_B$ dependence, while candidates from continuum are flat in $\cos\theta_B$.

In both the $K_S^0\pi^\pm h^\mp$ and $K^\pm h^\mp \pi^0$ topologies, the $h^\mp$ refers to the faster of the two tracks, which typically has momentum above 1 GeV/c. Because dE/dx still provides limited separation of pions and kaons above 1 GeV/c, we make use of the dE/dx information in the likelihood fit. In $B \to K^*(892)^\pm\pi^\mp$ decays, this higher-momentum track is the one that recoils from the $K^*(892)^\pm$, more than 99.99% of the time. Its charge uniquely distinguishes $\bar{B}^0 \to K^*(892)^-\pi^+$ from $B^0 \to K^*(892)^+\pi^-$. Thus, the charge asymmetry $\mathcal{A}_{+-}$, formed using the charge of this higher-momentum track, is essentially the same as $\mathcal{A}_{CP}$.

Our loose selection criteria result in samples consisting primarily of background events and containing 11893 candidates for $K_S^0\pi^\pm h^\mp$ and 28589 for $K^\pm h^\mp \pi^0$. To extract yields and CP asymmetries, we perform an unbinned maximum likelihood fit using the observables M, ΔE, $\mathcal{F}$, $\cos\theta_B$, the two Dalitz plot variables in each topology, and the dE/dx of the $h^\mp$

(the faster of the two primary tracks). At high momentum, charged pions and kaons are statistically separated by their dE/dx and by ΔE, each of which provides discrimination at the 2.0σ level (1.7σ for CLEO II), and we fit for both π and K hypotheses simultaneously. Charged pions and kaons with momentum below 1 GeV/c are cleanly identified by dE/dx consistency at the 3σ level. The free parameters in the fit are yields (N) summed over charge states, $N_{h^+} + N_{h^-}$, and charge asymmetries, $\mathcal{A}_{+-} \equiv (N_{h^+} - N_{h^-})/(N_{h^+} + N_{h^-})$.

The probability for a candidate to be consistent with a given component is the product of the probability density function (PDF) values for each of the input variables (neglecting correlations). The likelihood for each candidate is the sum of probabilities over the components in the fit, with relative weights determined by maximizing the total likelihood of the sample, which is given by the following expression:

$$\mathcal{L} = \prod_{i=1}^{\text{candidates}} \left\{ \sum_{j=1}^{\text{components}} \left[f_j (1 \pm \mathcal{A}^j_{+-}) \prod_{k=1}^{\text{variables}} \mathcal{P}_{ijk} \right] \right\}, \tag{2}$$

where the $\pm$ refers to the charge of $h^\pm$ in each candidate. The $\mathcal{P}_{ijk}$ are the per candidate PDF values, and the f_j and $\mathcal{A}^j_{+-}$ are the free parameters optimized by the fit. The products $f_j(1 \pm \mathcal{A}^j_{+-})/2$ are constrained to sum to the fraction of candidates in the fit with the appropriate charge of $h^\pm$. Since the PDFs are normalized to unit integral over the fit domain, the f_j can be interpreted as component fractions. The parameters of the dE/dx PDFs are measured from $D \to K^\pm\pi^\mp$ decays in data. For all other variables, the signal and the background $b \to c$ PDFs are determined from high-statistics Monte Carlo samples, and the continuum PDFs are determined from data collected below the $B\bar{B}$ production threshold. The impact of correlations among the input variables is reduced by determining the PDFs as a function of the event location in the Dalitz plot, for coarse bins in the $M^2(K\pi)$-$M^2(\pi\pi)$ plane. We use Monte Carlo simulation to estimate the systematic uncertainty associated with neglecting any remaining correlations.

Events from $B \to K^0_S\pi^\pm h^\mp$ and $B \to K^\pm h^\mp \pi^0$, including $B \to K^*(892)^\pm\pi^\mp$, are modeled in the fit as follows. We consider various B decay channels with intermediate resonances ($K^*(892)$, $K^*_0(1430)$, $\rho(770)$, and $f_0(980)$) as well as non-resonant phase space decay. The Dalitz plot PDFs include our knowledge of the helicity structure in these decays. We neglect interference among these signal processes and assign a systematic uncertainty estimated from Monte Carlo simulation. The decays $B \to \mathcal{K}^\pm h^\mp$, where $\mathcal{K}^\pm$ denotes $K^*(892)^\pm$ or $K^*_0(1430)^\pm$, are accessible through different $\mathcal{K}^\pm$ submodes in both the $K^0_S\pi^\pm h^\mp$ and $K^\pm h^\mp\pi^0$ topologies. To maximize our sensitivity to these decays, we fit these two topologies simultaneously, with the branching fraction and charge asymmetry for each $\mathcal{K}^\pm h^\mp$ decay constrained to be equal in its two $\mathcal{K}^\pm$ submodes, which are related by isospin.

The charge symmetry of the CLEO detector, the track reconstruction software, and the dE/dx measurement has previously been verified [7, 17]. The charge asymmetries of the fit samples are 0.010 ± 0.009 for $B \to K^0_S\pi^\pm h^\mp$ and 0.006 ± 0.006 for $B \to K^\pm h^\mp\pi^0$. Detection efficiencies and crossfeed among the charge-summed signal yields are measured from Monte Carlo simulated events and are accounted for in the fit for $\mathcal{A}_{+-}$. We find the charge asymmetry of the detection efficiencies to be consistent with the expected null result. Crossfeed among different charge states is not included in the fit, and its effect is estimated with Monte Carlo simulation.

We perform the fit with differing combinations of intermediate resonant and non-resonant states, with up to twelve signal components. The fitted value of $\mathcal{A}_{CP}$ does not depend heavily on the number of signal components in the fit, and we include a systematic uncertainty

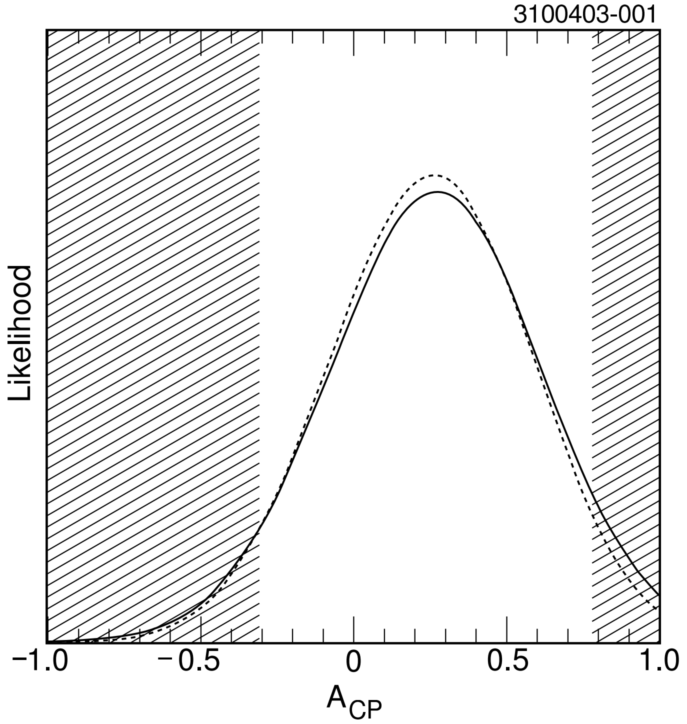

FIG. 1: Likelihood as a function of $\mathcal{A}_{CP}$ before (dashed) and after (solid) including systematic uncertainties. The hatched regions each contain 5% of the integrated area in the physical region and are excluded at the 90% confidence level.

for these variations. We also allow for four background components: pion and kaon hypotheses for $h^\pm$ for continuum background and background from $b \to c$ decays. We do not fit for charge asymmetries in the background components, but we measure them to be consistent with zero. The $B \to K^*(892)^\pm\pi^\mp$ event yields were measured to be [10] $12.6^{+4.6}_{-3.9}$ for $K^*(892)^\pm \to K^0_S\pi^\pm$ and $6.1^{+2.2}_{-1.9}$ for $K^*(892)^\pm \to K^\pm\pi^0$ with a combined statistical significance of 4.6σ. In the fit, these yields are corrected for efficiency and crossfeed from other modes, and the CP asymmetry in $B \to K^*(892)^\pm\pi^\mp$ is measured to be $\mathcal{A}_{CP} = 0.26^{+0.33+0.10}_{-0.34-0.08}$, where the uncertainties are statistical and systematic, respectively. The dominant contributions to the latter are statistical uncertainties in the PDFs and variations in the fitting method.

We determine the dependence of the likelihood function on $\mathcal{A}_{CP}$ by repeating the fit at several fixed values of $\mathcal{A}_{CP}$. By convoluting this function with the systematic uncertainties and integrating the resultant curve in the physical region, we construct a 90% confidence level interval of $-0.31 < \mathcal{A}_{CP} < 0.78$, where the excluded regions on both sides each contain 5% of the integrated area. Figure 1 shows the likelihood function given by the fit and the effect of including systematic uncertainties.

In summary, we have measured the CP asymmetry in $B \to K^*(892)^\pm\pi^\mp$ using a simultaneous maximum likelihood fit to the $B \to K^0_S\pi^\pm h^\mp$ and $B \to K^\pm h^\mp\pi^0$ topologies. We obtain the value $\mathcal{A}_{CP} = 0.26^{+0.33+0.10}_{-0.34-0.08}$, which is consistent with the theoretical predictions [5] of -0.19 to 0.47. We also establish a 90% confidence level interval of $[-0.31, 0.78]$.

We gratefully acknowledge the effort of the CESR staff in providing us with excellent luminosity and running conditions. M. Selen thanks the Research Corporation, and A.H.

Mahmood thanks the Texas Advanced Research Program. This work was supported by the National Science Foundation, and the U.S. Department of Energy.

---

[1] M. Kobayashi and T. Maskawa, Prog. Theor. Phys. **49**, 652 (1973).
[2] B. Aubert *et al.* [BaBar Collaboration], Phys. Rev. Lett. **89**, 201802 (2002) [arXiv:hep-ex/0207042]; K. Abe *et al.* [Belle Collaboration], Phys. Rev. D **66**, 071102 (2002) [arXiv:hep-ex/0208025].
[3] A. Alavi-Harati *et al.* [KTeV Collaboration], Phys. Rev. Lett. **83**, 22 (1999) [arXiv:hep-ex/9905060]; V. Fanti *et al.* [NA48 Collaboration], Phys. Lett. B **465**, 335 (1999) [arXiv:hep-ex/9909022].
[4] J. F. Donoghue, E. Golowich, A. A. Petrov and J. M. Soares, Phys. Rev. Lett. **77**, 2178 (1996) [arXiv:hep-ph/9604283]; M. Neubert and J. L. Rosner, Phys. Lett. B **441**, 403 (1998) [arXiv:hep-ph/9808493]; M. Beneke, G. Buchalla, M. Neubert and C. T. Sachrajda, Nucl. Phys. B **606**, 245 (2001) [arXiv:hep-ph/0104110]; Y. Y. Keum and A. I. Sanda, arXiv:hep-ph/0209014.
[5] D. S. Du, H. J. Gong, J. F. Sun, D. S. Yang and G. H. Zhu, Phys. Rev. D **65**, 094025 (2002) [Erratum-ibid. D **66**, 079904 (2002)] [arXiv:hep-ph/0201253]; Y. Y. Keum, arXiv:hep-ph/0210127.
[6] R. Fleischer and J. Matias, Phys. Rev. D **61**, 074004 (2000) [arXiv:hep-ph/9906274]; Y. Grossman, M. Neubert and A. L. Kagan, JHEP **9910**, 029 (1999) [arXiv:hep-ph/9909297].
[7] S. Chen *et al.* [CLEO Collaboration], Phys. Rev. Lett. **85**, 525 (2000) [arXiv:hep-ex/0001009].
[8] R. S. Lu *et al.*, Phys. Rev. Lett. **89**, 191801 (2002) [arXiv:hep-ex/0207019]; B. Aubert *et al.* [BABAR Collaboration], Phys. Rev. Lett. **89**, 281802 (2002) [arXiv:hep-ex/0207055]; B. Aubert *et al.* [BABAR Collaboration], arXiv:hep-ex/0207065; B. Aubert *et al.* [BABAR Collaboration], arXiv:hep-ex/0207068; B. C. Casey *et al.* [Belle Collaboration], Phys. Rev. D **66**, 092002 (2002) [arXiv:hep-ex/0207090];
[9] Belle Collaboration, K. Abe *et al.*, BELLE-CONF-0115 (2001), contributed to the Proceedings of the XX International Symposium on Lepton and Photon Interactions at High Energyis, July 23-28, 2001, Rome, Italy; Belle Collaboration, T. J. Gershon, arXiv:hep-ex/0205033; Belle Collaboration, H. C. Huang, arXiv:hep-ex/0205062.
[10] E. Eckhart *et al.* [CLEO Collaboration], Phys. Rev. Lett. **89**, 251801 (2002) [arXiv:hep-ex/0206024].
[11] CLEO Collaboration, Y. Kubota *et al.*, Nucl. Instrum Methods Phys. Res. A **320**, 66 (1992).
[12] T. S. Hill, Nucl. Instrum. Methods Phys. Res. A **418**, 32 (1998).
[13] R. Brun *et al.*, CERN DD/EE/84-1.
[14] S. L. Wu, Phys. Rep. C**107**, 59 (1984).
[15] CLEO Collaboration, D. Asner *et al.*, Phys. Rev. D**53**, 1039 (1996).
[16] G. Fox and S. Wolfram, Phys. Rev. Lett. **41**, 1581 (1978).
[17] T. E. Coan *et al.* [CLEO Collaboration], Phys. Rev. Lett. **84**, 5283 (2000) [arXiv:hep-ex/9912057].