Search for CP Violation in the Decays $D^0 \rightarrow K_S^0 P^0$

B. R. Ko,[17] E. Won,[17] K. Arinstein,[1,33] T. Aushev,[19,12] A. M. Bakich,[40] V. Balagura,[12] E. Barberio,[23] K. Belous,[11] V. Bhardwaj,[35] B. Bhuyan,[9] M. Bischofberger,[25] A. Bondar,[1,33] A. Bozek,[29] M. Bračko,[21,13] J. Brodzicka,[29] T. E. Browder,[7] A. Chen,[26] P. Chen,[28] B. G. Cheon,[6] C.-C. Chiang,[28] I.-S. Cho,[50] K. Cho,[16] K.-S. Choi,[50] S.-K. Choi,[5] Y. Choi,[39] S. Eidelman,[1,33] D. Epifanov,[1,33] M. Feindt,[15] N. Gabyshev,[1,33] A. Garmash,[1,33] B. Golob,[20,13] H. Ha,[17] J. Haba,[8] H. Hayashii,[25] Y. Horii,[45] Y. Hoshi,[44] W.-S. Hou,[28] H. J. Hyun,[18] T. Iijima,[24] K. Inami,[24] A. Ishikawa,[36] R. Itoh,[8] M. Iwabuchi,[50] T. Iwashita,[25] T. Julius,[23] J. H. Kang,[50] T. Kawasaki,[31] C. Kiesling,[22] H. O. Kim,[18] M. J. Kim,[18] Y. J. Kim,[16] K. Kinoshita,[3] P. Kodyš,[2] S. Korpar,[21,13] P. Križan,[20,13] R. Kumar,[35] A. Kuzmin,[1,33] Y.-J. Kwon,[50] S.-H. Kyeong,[50] M. J. Lee,[38] S.-H. Lee,[17] C. Liu,[37] D. Liventsev,[12] R. Louvot,[19] A. Matyja,[29] K. Miyabayashi,[25] H. Miyata,[31] Y. Miyazaki,[24] R. Mizuk,[12] G. B. Mohanty,[41] T. Mori,[24] E. Nakano,[34] M. Nakao,[8] S. Nishida,[8] K. Nishimura,[7] O. Nitoh,[48] S. Ogawa,[43] T. Ohshima,[24] S. Okuno,[14] S. L. Olsen,[38,7] P. Pakhlov,[12] C. W. Park,[39] H. Park,[18] H. K. Park,[18] R. Pestotnik,[13] M. Petrič,[13] L. E. Piilonen,[49] A. Poluektov,[1,33] M. Röhrken,[15] Y. Sakai,[8] O. Schneider,[19] C. Schwanda,[10] A. J. Schwartz,[3] K. Senyo,[24] M. E. Sevior,[23] M. Shapkin,[11] V. Shebalin,[1,33] C. P. Shen,[7] J.-G. Shiu,[28] B. Shwartz,[1,33] F. Simon,[22,42] J. B. Singh,[35] P. Smerkol,[13] Y.-S. Sohn,[50] E. Solovieva,[12] S. Stanič,[32] M. Starič,[13] M. Sumihama,[51,4] K. Sumisawa,[8] T. Sumiyoshi,[47] S. Tanaka,[8] Y. Teramoto,[34] K. Trabelsi,[8] M. Uchida,[51,46] S. Uehara,[8] T. Uglov,[12] Y. Unno,[6] Y. Usov,[1,33] G. Varner,[7] K. E. Varvell,[40] A. Vinokurova,[1,33] C. H. Wang,[27] M.-Z. Wang,[28] Y. Watanabe,[14] Y. Yamashita,[30] M. Yamauchi,[8] Z. P. Zhang,[37] V. Zhilich,[1,33] V. Zhulanov,[1,33] A. Zupanc,[15] and O. Zyukova[1,33]

(Belle Collaboration)

[1]*Budker Institute of Nuclear Physics, Novosibirsk*
[2]*Faculty of Mathematics and Physics, Charles University, Prague*
[3]*University of Cincinnati, Cincinnati, Ohio 45221*
[4]*Gifu University, Gifu*
[5]*Gyeongsang National University, Chinju*
[6]*Hanyang University, Seoul*
[7]*University of Hawaii, Honolulu, Hawaii 96822*
[8]*High Energy Accelerator Research Organization (KEK), Tsukuba*
[9]*Indian Institute of Technology Guwahati, Guwahati*
[10]*Institute of High Energy Physics, Vienna*
[11]*Institute of High Energy Physics, Protvino*
[12]*Institute for Theoretical and Experimental Physics, Moscow*
[13]*J. Stefan Institute, Ljubljana*
[14]*Kanagawa University, Yokohama*
[15]*Institut für Experimentelle Kernphysik, Karlsruher Institut für Technologie, Karlsruhe*
[16]*Korea Institute of Science and Technology Information, Daejeon*
[17]*Korea University, Seoul*
[18]*Kyungpook National University, Taegu*
[19]*École Polytechnique Fédérale de Lausanne (EPFL), Lausanne*
[20]*Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana*
[21]*University of Maribor, Maribor*
[22]*Max-Planck-Institut für Physik, München*
[23]*University of Melbourne, School of Physics, Victoria 3010*
[24]*Nagoya University, Nagoya*
[25]*Nara Women's University, Nara*
[26]*National Central University, Chung-li*
[27]*National United University, Miao Li*
[28]*Department of Physics, National Taiwan University, Taipei*
[29]*H. Niewodniczanski Institute of Nuclear Physics, Krakow*
[30]*Nippon Dental University, Niigata*
[31]*Niigata University, Niigata*
[32]*University of Nova Gorica, Nova Gorica*
[33]*Novosibirsk State University, Novosibirsk*
[34]*Osaka City University, Osaka*
[35]*Panjab University, Chandigarh*

[36]*Saga University, Saga*
[37]*University of Science and Technology of China, Hefei*
[38]*Seoul National University, Seoul*
[39]*Sungkyunkwan University, Suwon*
[40]*School of Physics, University of Sydney, NSW 2006*
[41]*Tata Institute of Fundamental Research, Mumbai*
[42]*Excellence Cluster Universe, Technische Universität München, Garching*
[43]*Toho University, Funabashi*
[44]*Tohoku Gakuin University, Tagajo*
[45]*Tohoku University, Sendai*
[46]*Tokyo Institute of Technology, Tokyo*
[47]*Tokyo Metropolitan University, Tokyo*
[48]*Tokyo University of Agriculture and Technology, Tokyo*
[49]*CNP, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061*
[50]*Yonsei University, Seoul*
[51]*Research Center for Nuclear Physics, Osaka*

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We have searched for CP violation in the decays $D^0 \to K_S^0 P^0$ where P^0 denotes a neutral pseudoscalar meson that is either a π^0, η, or η' using KEKB asymmetric-energy e^+e^- collision data corresponding to an integrated luminosity of 791 fb^{-1} collected with the Belle detector. No evidence of significant CP violation is observed. We report the most precise CP asymmetry measurement in the decay $D^0 \to K_S^0 \pi^0$ to date: $A_{CP}^{D^0 \to K_S^0 \pi^0} = (-0.28 \pm 0.19 \pm 0.10)\%$. We also report the first measurements of CP asymmetries in the decays $D^0 \to K_S^0 \eta$ and $D^0 \to K_S^0 \eta'$: $A_{CP}^{D^0 \to K_S^0 \eta} = (+0.54 \pm 0.51 \pm 0.16)\%$ and $A_{CP}^{D^0 \to K_S^0 \eta'} = (+0.98 \pm 0.67 \pm 0.14)\%$, respectively.

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The recent evidence for $D^0 - \bar{D}^0$ mixing [1–3] and the corresponding mixing parameters [4] are at the upper edge of standard model (SM) predictions [5]. However, large theoretical uncertainties in these predictions limit the sensitivity to effects of physics beyond the SM. An alternative, potentially more promising approach to search for new physics (NP) is the study of violation of the combined charge-conjugation and parity symmetries (CP) in the decays of charmed mesons [6]. SM CP violation in charm decays is small [7] and thus is a clear signature of NP at the current level of experimental sensitivity. In this Letter we report time-integrated CP asymmetry measurements in the decays $D^0 \to K_S^0 P^0$ [8] where P^0 denotes a neutral pseudoscalar meson: π^0, η, or η'. The time-integrated asymmetry, A_{CP}, is defined as

$$A_{CP}^{D^0 \to K_S^0 P^0} = \frac{\Gamma(D^0 \to K_S^0 P^0) - \Gamma(\bar{D}^0 \to K_S^0 P^0)}{\Gamma(D^0 \to K_S^0 P^0) + \Gamma(\bar{D}^0 \to K_S^0 P^0)}, \tag{1}$$

where Γ is the partial decay width.

The observed $K_S^0 P^0$ final states are mixtures of $D^0 \to \bar{K}^0 P^0$ and $D^0 \to K^0 P^0$ decays where the former are Cabibbo-favored (CF) and the latter are doubly Cabibbo-suppressed (DCS). In the absence of direct CP violation in CF and DCS decays within the SM, SM CP violation in these processes is generated from mixing and interference of decays with and without mixing, which is parametrized by a^{ind} (we adopt the symbols used in Ref. [6]). SM $K^0 - \bar{K}^0$ mixing leads to a small CP asymmetry in final states containing a neutral kaon, even if no CP violating phase exists in the charm decay. The asymmetry that is expected from the SM is measured to be $(-0.332 \pm 0.006)\%$ [9] from K_L^0 semileptonic decays and referred to as $A_{CP}^{\bar{K}^0}$ [10], which is reflected in the value of $A_{CP}^{D^0 \to K_S^0 P^0}$ if DCS decay contributions are ignored. Since the a^{ind} value expected from the SM is at most $\mathcal{O}(10^{-4})$ [6,7], the value of CP asymmetry in the decays $D^0 \to K_S^0 P^0$ within the SM is approximately $A_{CP}^{\bar{K}^0}$. On the other hand, if NP processes contain additional weak phases other than the one in the Kobayashi-Maskawa ansatz [11], interferences between CF and DCS decays could generate $\mathcal{O}(1)\%$ direct CP asymmetry in the decays $D^0 \to K_S^0 P^0$ [12]. NP could also induce $\mathcal{O}(1)\%$ indirect CP asymmetry [6]. Thus, observing A_{CP} inconsistent with $A_{CP}^{\bar{K}^0}$ in $D^0 \to K_S^0 P^0$ decays would be strong evidence for processes involving NP [6,12].

In addition to A_{CP} measurements, we examine the universality of a^{ind} in D^0 decays [6] by comparing our previous result [2] with the $A_{CP}^{D^0 \to K_S^0 \pi^0}$ value reported in this Letter. Our previously measured values of direct CP violation asymmetries (denoted a_f^d [6]), $a_{D^0 \to K^+K^-}^d$ and $a_{D^0 \to \pi^+\pi^-}^d$ [13], are also updated.

The decay $D^{*+} \to D^0 \pi_s^+$ is used to identify the flavor of the D^0 meson from the charge of the low momentum pion (referred to as "the soft pion"), π_s^+. Thus, we determine $A_{CP}^{D^0 \to K_S^0 P^0}$ by measuring the asymmetry in the signal yield

$$A_{\rm rec}^{D^{*+}\to D^0\pi_s^+} = \frac{N_{\rm rec}^{D^{*+}\to D^0\pi_s^+} - N_{\rm rec}^{D^{*-}\to \bar{D}^0\pi_s^-}}{N_{\rm rec}^{D^{*+}\to D^0\pi_s^+} + N_{\rm rec}^{D^{*-}\to \bar{D}^0\pi_s^-}}, \tag{2}$$

where $N_{\rm rec}$ is the number of reconstructed decays. The measured asymmetry in Eq. (2) includes the forward-backward asymmetry (A_{FB}) due to γ^*-Z^0 interference in $e^+e^- \to c\bar{c}$ and a detection efficiency asymmetry between π_s^+ and π_s^- ($A_\epsilon^{\pi_s^+}$) as well as A_{CP}. Since we reconstruct the K_S^0 with $\pi^+\pi^-$ combinations and P^0 with the $\gamma\gamma$ or $\gamma\gamma\pi^+\pi^-$ final states, asymmetries in K_S^0 and P^0 detection cancel out. Equation (2) then can be simplified to give

$$\begin{aligned} A_{\rm rec}^{D^{*+}\to D^0\pi_s^+} &= A_{CP}^{D^0\to K_S^0P^0} + A_{FB}^{D^{*+}}(\cos\theta_{D^{*+}}^{\rm c.m.s.}) \\ &\quad + A_\epsilon^{\pi_s^+}(p_{T\pi_s^+}^{\rm lab}, \cos\theta_{\pi_s^+}^{\rm lab}) \end{aligned} \tag{3}$$

by neglecting the terms involving the product of asymmetries. In Eq. (3) A_{CP} is independent of all kinematic variables, $A_{FB}^{D^{*+}}$ is an odd function of the cosine of the polar angle of the D^{*+} momentum in the center-of-mass system (c.m.s.), and $A_\epsilon^{\pi_s^+}$ depends on the transverse momentum and the polar angle of the π_s^+ in the laboratory frame, while it is uniform in azimuthal angle. To correct for $A_\epsilon^{\pi_s^+}$ we use the decays $D^0 \to K^-\pi^+$ (referred to as untagged) and $D^{*+} \to D^0\pi_s^+ \to K^-\pi^+\pi_s^+$ (referred to as tagged), and assume the same A_{FB} for D^{*+} and D^0 mesons. By subtracting the measured asymmetries in these two decay modes, $A_{\rm rec}^{\rm untagged}$ and $A_{\rm rec}^{\rm tagged}$, we directly measure the $A_\epsilon^{\pi_s^+}$ correction factor [13,14]. With $A_{\rm rec}^{D^{*+}\to D^0\pi_s^+}$ corrected for $A_\epsilon^{\pi_s^+}$ (denoted $A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+}$ below),

$$A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+} = A_{CP}^{D^0\to K_S^0P^0} + A_{FB}^{D^{*+}}(\cos\theta_{D^{*+}}^{\rm c.m.s.}), \tag{4}$$

we extract A_{CP} and A_{FB} using

$$\begin{aligned} A_{CP}^{D^0\to K_S^0P^0} &= [A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+}(+\cos\theta_{D^{*+}}^{\rm c.m.s.}) \\ &\quad + A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+}(-\cos\theta_{D^{*+}}^{\rm c.m.s.})]/2, \end{aligned} \tag{5a}$$

$$\begin{aligned} A_{FB}^{D^{*+}} &= [A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+}(+\cos\theta_{D^{*+}}^{\rm c.m.s.}) \\ &\quad - A_{\rm rec,corr}^{D^{*+}\to D^0\pi_s^+}(-\cos\theta_{D^{*+}}^{\rm c.m.s.})]/2. \end{aligned} \tag{5b}$$

The data used in this analysis were recorded at or near the $\Upsilon(4S)$ resonance with the Belle detector [15] at the e^+e^- asymmetric-energy collider KEKB [16]. The sample corresponds to an integrated luminosity of 791 fb^{-1}.

We apply the same charged track selection criteria that were used in Ref. [17]. For soft pions we do not require associated hits in the silicon vertex detector, either in the z or radial directions [18]. We use the standard Belle charged kaon, charged pion identification, and K_S^0 selection requirements, which are described in detail in Ref. [17]. Candidate π^0 and η mesons are reconstructed from $\gamma\gamma$ pairs where the minimum energy of each γ is required to be 60 MeV for the barrel and 100 MeV for the forward region of the calorimeter [19] and the minimum momentum of the pairs is to be 0.5 GeV/c. We require $M(\gamma\gamma)$ to be between 0.11 and 0.16 GeV/c^2 for π^0 candidates and between 0.50 and 0.58 GeV/c^2 for η candidates. To remove a significant π^0 photon background under the η signal peak, we combine individual γ candidates from $\eta \to \gamma\gamma$ with any other detected γ in the event. If the $\gamma\gamma$ pair invariant mass is in the π^0 mass window, the γ is rejected. Further reduction of the π^0 contribution under the η signal is achieved by requiring the energy balance of the $\gamma\gamma$ in the η decay to be less than 0.8, where the energy balance is the ratio of the difference and the sum of two γ energies. Candidate η' mesons are reconstructed in the $\eta\pi^+\pi^-$ decay where the η is reconstructed as described above without the π^0 veto. After recalculating the four-momentum of the η with a nominal η mass [9] constraint, the $M(\eta\pi^+\pi^-)$ is required to be between 0.945 and 0.970 GeV/c^2. The four-momentum of the P^0 is recalculated from a kinematic fit to its nominal mass [9] and combined with a K_S^0 to form a D^0 candidate. D^{*+} candidates are reconstructed

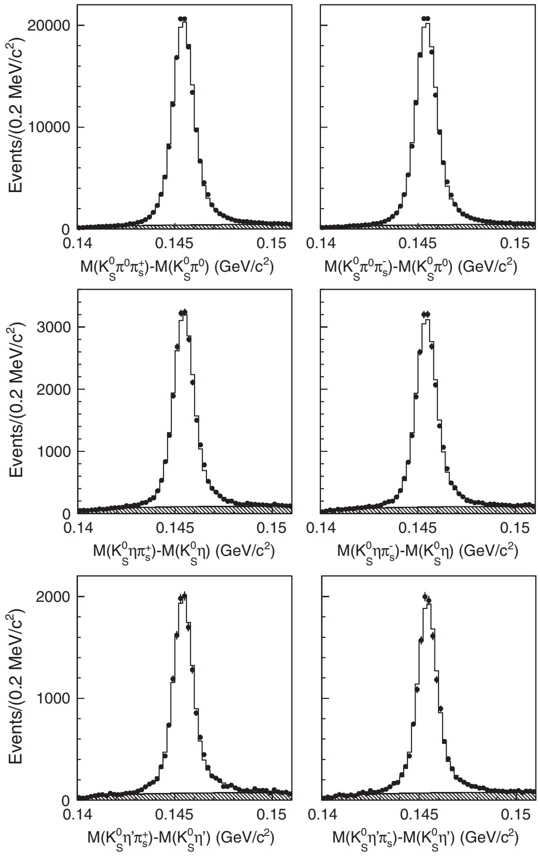

FIG. 1. Distributions of the $M(D^*) - M(D)$ for the studied decay modes. Left plots show the $M(D^{*+}) - M(D^0)$ and right plots show the $M(D^{*-}) - M(\bar{D}^0)$. Top plots are for the $K_S^0\pi^0$, middle plots for the $K_S^0\eta$, and bottom plots for the $K_S^0\eta'$ final states. Points with error bars are the data, and the histograms show the results of the parametrizations of the data. Hatched areas are the background contributions.

TABLE I. The sum (N_S) and the asymmetry [$A_{\rm rec}$ in Eq. (2)] of D^{*+} and D^{*-} yields from the fits. The uncertainties are statistical only.

	N_S	$A_{\rm rec}$ (%)
$D^{*+} \to D^0\pi_s^+ \to K_S^0\pi^0\pi_s^+$	$326\,303 \pm 679$	$+0.19 \pm 0.19$
$D^{*+} \to D^0\pi_s^+ \to K_S^0\eta\pi_s^+$	$45\,831 \pm 283$	$+1.00 \pm 0.51$
$D^{*+} \to D^0\pi_s^+ \to K_S^0\eta'\pi_s^+$	$26\,899 \pm 211$	$+1.47 \pm 0.67$

using a π_s^+ and a D^0 candidate with mass in the $[1.75, 1.95]$ GeV/c^2 ($K_S^0\pi^0$), $[1.82, 1.90]$ GeV/c^2 ($K_S^0\eta$), or $[1.84, 1.89]$ GeV/c^2 ($K_S^0\eta'$) interval which depends on the mass resolution. To remove D^{*+} mesons produced in B decays, the D^{*+} momentum in the c.m.s. is required to be greater than 2.5 GeV/c. All selections are chosen to maximize N_S/σ_{N_S} and to minimize the peaking backgrounds, where N_S is the signal yield from the fit and σ_{N_S} is the uncertainty in N_S. After applying all of the selections described above, the $D^0 \to \pi^+\pi^-\pi^0$ contribution to $D^0 \to K_S^0\pi^0$ and the $D^0 \to K_S^0\pi^0$ contribution to $D^0 \to K_S^0\eta$ are found to be negligible in simulation studies. Figure 1 shows data distributions of the mass difference, $M(D^*) - M(D)$, for all the decay modes.

All mass difference signals are parametrized as a sum of a Gaussian and a bifurcated Gaussian distribution with a common mean. The background is parametrized by the form $(x - m_{\pi^+})^\alpha e^{-\beta(x-m_{\pi^+})}$, where α and β are free parameters, m_{π^+} is the charged pion mass [9], and x is the $M(D^*) - M(D)$. The asymmetry and the sum of the D^{*+} and D^{*-} yields are directly obtained from a simultaneous fit to the D^{*+} and D^{*-} candidate distributions. The common parameters in the simultaneous fit are the mean of the Gaussian, the widths of the Gaussian and the bifurcated Gaussian, and the ratio of the Gaussian and the bifurcated Gaussian amplitudes, which are the same for the $M(D^*) - M(D)$ distributions in different $K_S^0P^0$ final states and in the slightly different phase spaces of the individual $K_S^0P^0$ modes. Table I lists the results of the fits.

To obtain $A_\epsilon^{\pi_s^+}$ we first extract $A_{\rm rec}^{\rm untagged}$ using simultaneous fits analogous to those used for the signal modes, but instead of the $M(D^*) - M(D)$ distribution we fit to the $M(D)$ distribution using a similar parametrization. The values of $A_{\rm rec}^{\rm untagged}$ are evaluated in bins of $p_{TD^0}^{\rm lab}$ and $\cos\theta_{D^0}^{\rm lab}$. The p_T and polar angle variables are only weakly

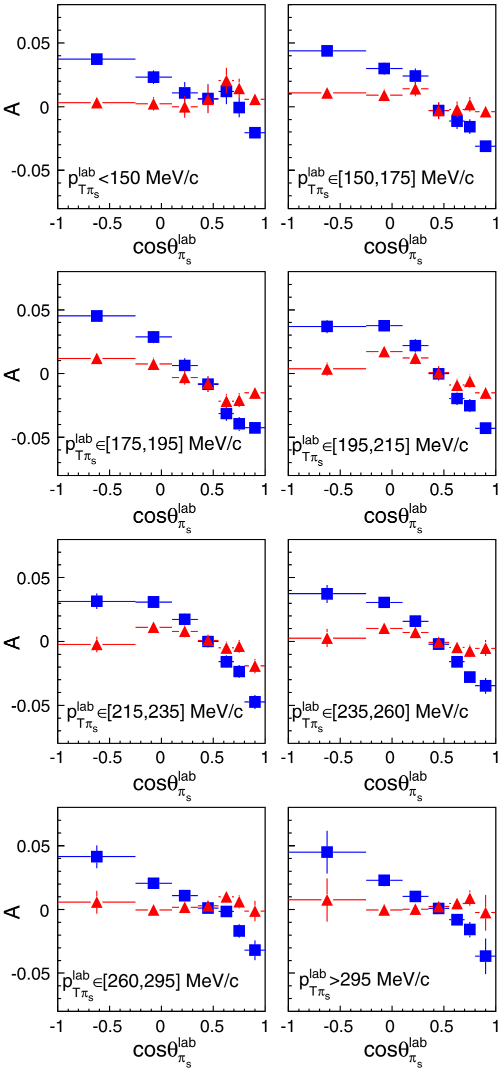

FIG. 2 (color online). $A_\epsilon^{\pi_s^+}$ map in bins of $p_T^{\rm lab}$ and $\cos\theta^{\rm lab}$ of the π_s^+ obtained with around 11×10^6 untagged and 2.5×10^6 tagged events (triangles). The $A_{\rm rec}^{\rm tagged}$ map obtained with tagged candidates is also shown (rectangles).

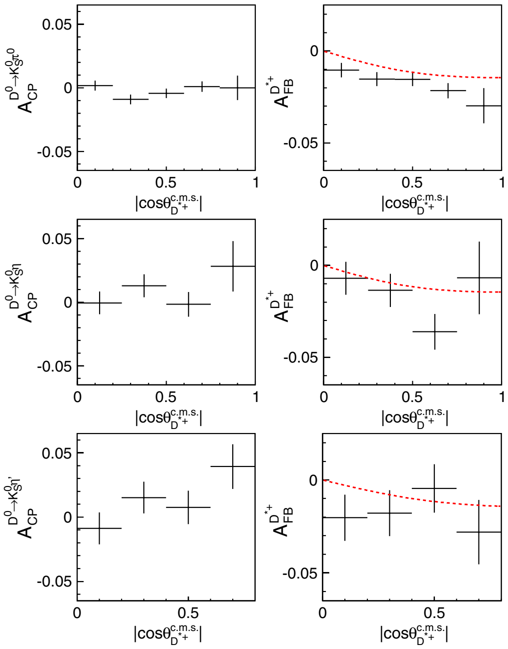

FIG. 3 (color online). Measured A_{CP} (left) and A_{FB} (right) values as a function of $|\cos\theta_{D^{*+}}^{\rm c.m.s.}|$. Top plots are for $K_S^0\pi^0$, middle plots for $K_S^0\eta$, and bottom plots for $K_S^0\eta'$ final states. The dashed curves show the leading-order prediction for $A_{FB}^{c\bar{c}}$.

TABLE II. Summary of systematic uncertainties in A_{CP}.

Source	$K_S^0\pi^0$ (%)	$K_S^0\eta$ (%)	$K_S^0\eta'$ (%)
$A_\epsilon^{\pi_s^+}$ determination	0.08	0.08	0.08
Fitting	0.02	0.12	0.10
$\cos\theta_{D^{*+}}^{\text{c.m.s.}}$ binning	<0.01	0.01	0.03
$K^0/\bar{K}^0$ material effects	0.06	0.06	0.06
Total	0.10	0.16	0.14

TABLE III. Summary of the A_{CP} measurements. The first uncertainties in the second column are statistical and the second are systematic. The third column shows the world average of A_{CP} and the fourth $A_{CP}^{\bar{K}^0}$. No world average is shown for the first measurements of $A_{CP}^{D^0\to K_S^0\eta^{(\prime)}}$.

	Belle (%)	Ref. [9] (%)	$A_{CP}^{\bar{K}^0}$ (%)
$A_{CP}^{D^0\to K_S^0\pi^0}$	$-0.28\pm0.19\pm0.10$	$+0.1\pm1.3$	-0.332 ± 0.006
$A_{CP}^{D^0\to K_S^0\eta}$	$+0.54\pm0.51\pm0.16$	$\cdots$	-0.332 ± 0.006
$A_{CP}^{D^0\to K_S^0\eta'}$	$+0.98\pm0.67\pm0.14$	$\cdots$	-0.332 ± 0.006

correlated. Each tagged $D^*\to D\pi_s\to K\pi\pi_s$ candidate is then weighted with a factor of $1\mp A_{\text{rec}}^{\text{untagged}}$ for $D^{*\pm}$. After this weighting the asymmetry in the tagged decay sample is $A_\epsilon^{\pi_s^+}$, which is measured from simultaneous fits to the weighted $M(D^*)-M(D)$ distributions in bins of $p_{T\pi_s^+}^{\text{lab}}$ and $\cos\theta_{\pi_s^+}^{\text{lab}}$ with the same parametrization used in the signal modes. Figure 2 shows the measured $A_\epsilon^{\pi_s^+}$ in bins of $p_{T\pi_s^+}^{\text{lab}}$ and $\cos\theta_{\pi_s^+}^{\text{lab}}$ together with $A_{\text{rec}}^{\text{tagged}}$ for comparison. The dominant sources of uncertainty in the $A_\epsilon^{\pi_s^+}$ determination are the statistical uncertainties in the untagged and tagged samples. These are found to be 0.04% and 0.07%, respectively. Other sources of systematic uncertainties are found to be negligible. Thus, we assign a systematic uncertainty of 0.08% to the $A_\epsilon^{\pi_s^+}$ determination, obtained by adding the two contributions in quadrature.

The data samples shown in Fig. 1 are divided into bins of $p_{T\pi_s^+}^{\text{lab}}$ and $\cos\theta_{\pi_s^+}^{\text{lab}}$. The $A_\epsilon^{\pi_s^+}$ correction is applied by weighting each $D^{*\pm}$ event with $1\mp A_\epsilon^{\pi_s^+}$. The weighted $M(D^*)-M(D)$ distributions in bins of $\cos\theta_{D^{*+}}^{\text{c.m.s.}}$ are fitted simultaneously to obtain the corrected asymmetry. We fit for the linear component in $\cos\theta_{D^{*+}}^{\text{c.m.s.}}$ to determine A_{FB} while the A_{CP} component is uniform in $\cos\theta_{D^{*+}}^{\text{c.m.s.}}$. Figure 3 shows $A_{CP}^{D^0\to K_S^0P^0}$ and $A_{FB}^{D^{*+}}$ as a function of $|\cos\theta_{D^{*+}}^{\text{c.m.s.}}|$. From a weighted average over the $|\cos\theta_{D^{*+}}^{\text{c.m.s.}}|$ bins, we obtain $A_{CP}^{D^0\to K_S^0\pi^0}=(-0.28\pm0.19)\%$, $A_{CP}^{D^0\to K_S^0\eta}=(+0.54\pm0.51)\%$, and $A_{CP}^{D^0\to K_S^0\eta'}=(+0.98\pm0.67)\%$ where the uncertainties are statistical only. The χ^2/d.o.f with respect to the average over the $|\cos\theta_{D^{*+}}^{\text{c.m.s.}}|$ bins is $5.1/4(K_S^0\pi^0)$, $3.0/3(K_S^0\eta)$, or $5.3/3(K_S^0\eta')$. The observed A_{FB} values decrease with $\cos\theta_{D^{*+}}^{\text{c.m.s.}}$ as expected from the leading-order prediction [20]. The observed deviations from the prediction are expected due to higher order corrections. The results are validated with toy pseudoexperiments and fully simulated Monte Carlo events. We find no systematic deviations from the input values.

We consider other sources of systematic uncertainty. To estimate the systematic uncertainty due to the choice of fitting method, we vary the histogram binnings, fitting intervals, and signal and background parametrizations. We also consider the systematic uncertainties due to the choice of $\cos\theta_{D^{*+}}^{\text{c.m.s.}}$ binning. Finally, we include possible effects due to the differences in interactions of K^0 and $\bar{K}^0$ mesons with the material of the detector as explained in Ref. [21], and assign a systematic uncertainty of 0.06% due to this effect. Table II summarizes the components of the systematic uncertainties. The larger uncertainties in $A_{CP}^{D^0\to K_S^0\eta^{(\prime)}}$ due to the choice of fitting method are a consequence of the smaller sample size in these modes. Table III summarizes the results, current world average [9], and $A_{CP}^{\bar{K}^0}$. Besides the A_{CP} measurements listed in Table III, we test the universality of a^{ind} assuming negligible new CP violating effects in D^0 decays to the $K_S^0\pi^0$ final state as discussed in Ref. [6]. By subtracting $A_{CP}^{\bar{K}^0}$ from $A_{CP}^{D^0\to K_S^0\pi^0}$, we obtain $a^{\text{ind}}=(+0.05\pm0.19\pm0.10)\%$, which is consistent with $-A_\Gamma=(-0.01\pm0.30\pm0.15)\%$ obtained in Ref. [2]. This is the first experimental test of a^{ind} in D^0 decays with a sensitivity near 0.3%. By averaging the two independent values we obtain $a^{\text{ind}}=(+0.03\pm0.18)\%$, where the uncertainty includes the statistical and systematic errors, and represents currently the most precise value of a^{ind} from a single experiment. Using the average a^{ind}, we also update the values of $a_{D^0\to K^+K^-}^d$ and $a_{D^0\to\pi^+\pi^-}^d$ from Ref. [13], which are $(-0.46\pm0.37)\%$ and $(+0.40\pm0.56)\%$ [22], respectively. The errors include all the uncertainties of input measurements.

In summary, we report a search for CP violation in the decays $D^0\to K_S^0P^0$ using a data sample with an integrated luminosity of 791 fb^{-1} collected with the Belle detector. We observe no evidence for CP violation. The measurement in the decay $D^0\to K_S^0\pi^0$ is the most precise measurement of A_{CP} in D^0 decays to date. We also report the first measurements of CP asymmetries in the decays $D^0\to K_S^0\eta^{(\prime)}$. Our results are consistent with the SM and can be used to place the most stringent constraints on NP models arising from the measurements of CP violation in the charm sector at present.

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