Observation of a Charged $(D\bar{D}^*)^\pm$ Mass Peak in $e^+e^- \to \pi D\bar{D}^*$ at $\sqrt{s} = 4.26$ GeV

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We report on a study of the process $e^+e^- \to \pi^\pm(D\bar{D}^*)^\mp$ at $\sqrt{s} = 4.26$ GeV using a 525 pb^{-1} data sample collected with the BESIII detector at the BEPCII storage ring. A distinct charged structure is observed in the $(D\bar{D}^*)^\mp$ invariant mass distribution. When fitted to a mass-dependent-width Breit-Wigner line shape, the pole mass and width are determined to be $M_{\rm pole} = (3883.9 \pm 1.5\ ({\rm stat}) \pm 4.2\ ({\rm syst}))\ {\rm MeV}/c^2$ and $\Gamma_{\rm pole} = (24.8 \pm 3.3\ ({\rm stat}) \pm 11.0\ ({\rm syst}))$ MeV. The mass and width of the structure, which we refer to as $Z_c(3885)$, are 2σ and 1σ, respectively, below those of the $Z_c(3900) \to \pi^\pm J/\psi$ peak observed by BESIII and Belle in $\pi^+\pi^- J/\psi$ final states produced at the same center-of-mass energy. The angular distribution of the $\pi Z_c(3885)$ system favors a $J^P = 1^+$ quantum number assignment for the structure and disfavors 1^- or 0^-. The Born cross section times the $D\bar{D}^*$ branching fraction of the $Z_c(3885)$ is measured to be $\sigma(e^+e^- \to \pi^\pm Z_c(3885)^\mp) \times \mathcal{B}(Z_c(3885)^\mp \to (D\bar{D}^*)^\mp) = (83.5 \pm 6.6\ ({\rm stat}) \pm 22.0\ ({\rm syst}))$ pb. Assuming the $Z_c(3885) \to D\bar{D}^*$ signal reported here and the $Z_c(3900) \to \pi J/\psi$ signal are from the same source, the partial width ratio $(\Gamma(Z_c(3885) \to D\bar{D}^*)/\Gamma(Z_c(3900) \to \pi J/\psi)) = 6.2 \pm 1.1$ (stat) ± 2.7 (syst) is determined.

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The $Y(4260)$ resonance is a peak in the cross section for $e^+e^- \to \pi^+\pi^- J/\psi$ near $\sqrt{s} = 4.26$ GeV first seen by *BABAR* [1] and subsequently confirmed by CLEO [2] and Belle [3]. Its production via the e^+e^- annihilation process requires the $Y(4260)$ quantum numbers to be $J^{PC} = 1^{--}$. A peculiar feature is the absence of any apparent corresponding structure in the cross sections for $e^+e^- \to D^{(*)}\bar{D}^{(*)}(\pi)$ in the same energy region [4]. This implies a partial-width lower-limit of $\Gamma(Y(4260) \to \pi^+\pi^- J/\psi) > 1$ MeV [5] that is 1 order of magnitude larger than is typical for conventional charmonium meson transitions [6], and indicates that the $Y(4260)$ is probably not a conventional quarkonium state.

A similar pattern is seen in the b-quark sector, where anomalously large cross sections for $e^+e^- \to \pi^+\pi^-\Upsilon(nS)$ $(n = 1, 2, 3)$ at energies around $\sqrt{s} = 10.86$ GeV reported by Belle [7] were found to be associated with the production of charged bottomoniumlike resonances, the $Z_b(10\,610)^+$ and $Z_b(10\,650)^+$, both with strong decays to $\pi^+\Upsilon(nS)$ and $\pi^+h_b(mP)$ $(m = 1, 2)$ [8]. (In this Letter, the inclusion of charge conjugate states is always implied.) The proximity of the $Z_b(10\,610)^+$ mass to the $m_B + m_{B^*}$ threshold and the $Z_b(10\,650)^+$ mass to the $2m_{B^*}$ threshold have led to suggestions that these states may be moleculelike meson-meson virtual states [9], a subject of considerable interest [10].

Recently, BESIII reported [11], and Belle confirmed [12], the observation of a prominent resonancelike charged structure in the π^+J/ψ invariant mass distribution for $e^+e^- \to \pi^+\pi^- J/\psi$ events collected at $\sqrt{s} = 4.26$ GeV, dubbed the $Z_c(3900)$, with $M = (3899.0 \pm 3.6 \pm 4.9)$ MeV$/c^2$ and $\Gamma = (46 \pm 10 \pm 20)$ MeV. (In this Letter, the first errors are statistical and the second systematic.) The $Z_c(3900)$ mass is 24 MeV$/c^2$ above the $D\bar{D}^*$ mass threshold, which is suggestive of a virtual $D\bar{D}^*$ moleculelike structure [13,14], i.e., a charmed-sector analog of the $Z_b(10\,610)$. BESIII also reported resonancelike structures in charged $D^*\bar{D}^*$ and π^+h_c systems at $M \simeq 4025$ MeV$/c^2$, which may be due to a charmed-sector analog of the $Z_b(10\,650)$ [15]. Another possibility is a diquark-diantiquark state [16]. It is important to measure the rate for $Z_c(3900)$ decays to $D\bar{D}^*$ and compare it to that for the $\pi J/\psi$ final state.

Here, we report the observation of a peak in the $(D\bar{D}^*)^-$ invariant-mass distribution in $e^+e^- \to \pi^+(D\bar{D}^*)^-$ annihilation events at $\sqrt{s} = 4.26$ GeV with a 525 pb^{-1} data sample detected by the BESIII detector at the BEPCII electron-positron collider. In the following, this structure is referred to as the $Z_c(3885)$. The $\pi^+(D\bar{D}^*)^-$ final states are selected with a partial reconstruction technique that only requires the detection of the bachelor π^+ and one final-state D meson; the presence of the $\bar{D}^*$ is inferred from energy-momentum conservation. We perform parallel analyses of two isospin channels ($\pi^+D^0D^{*-}$ and $\pi^-D^+\bar{D}^{*0}$) as a consistency check. The D mesons are reconstructed in the $D^0 \to K^-\pi^+$ and $D^+ \to K^-\pi^+\pi^+$ decay channels.

The BESIII detector [17] is a large-solid-angle spectrometer containing a a 50-layer Helium-gas-based main cylindrical drift chamber (MDC), a barrel-like arrangement of time-of-flight (TOF) scintillation counters, and an electromagnetic calorimeter comprised of CsI(Tl) crystals located inside a superconducting solenoid coil that provides a 1 T magnetic field. The charged particle momentum resolution for 1 GeV$/c$ charged tracks is 0.5% and the energy resolution for 1 GeV photons is 2.5%. Measurements of dE/dx in the MDC and TOF flight times are combined into pion, kaon, and proton identification (ID) probabilities. The hypothesis with the highest ID probability is assigned to each track.

To study the detector response and identify potential backgrounds, we use Monte Carlo (MC) event samples produced by the EVTGEN generator [18] in conjunction with KKMC [19], which generates initial-state radiation photons, and simulated using a GEANT4-based [20] software package [21].

For the π^+D^0-tag analysis, we select events with three or more well reconstructed charged tracks in the polar angle region $|\cos\theta| < 0.93$, with points of closest approach to the e^+e^- interaction point that are within ± 10 cm in the beam direction and 1 cm transverse to the beam direction. At least one track must be negatively charged and identified as a kaon and at least two have to be positively charged and identified as pions. We designate $K^-\pi^+$ combinations with invariant mass within 15 MeV$/c^2$ of m_{D^0} as D^0 candidates [22]. For events with two or more D^0 candidates, we retain the one with invariant mass closest to m_{D^0}. For the π^-D^+-tag analysis, we require one additional π^- track that is classified as the bachelor pion and use the mass requirement $|M(K^-\pi^+\pi^+) - m_{D^+}| < 15$ MeV$/c^2$ to

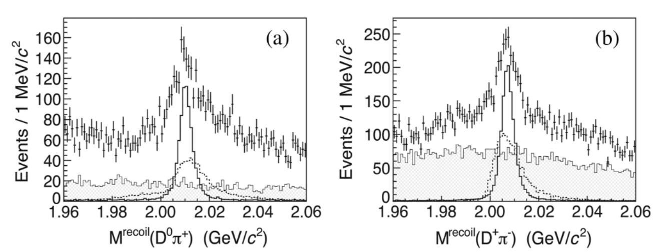

FIG. 1. The πD recoil mass distribution for the (a) π^+D^0 and (b) π^-D^+ tag events. Points with errors are data, the hatched histogram shows the events from the D mass sidebands. The solid and dashed histograms are described in the text.

select the D^+ candidates. We use events in 30 MeV/c^2-wide sideband regions centered at 40 MeV/c^2 above and below the D mass peaks to evaluate non-D meson backgrounds.

Figure 1(a) shows the distribution of masses recoiling against the detected $\pi^+ D^0$ system [23], where a prominent peak at $m_{D^{*-}}$ is evident. The solid-line histogram shows the same distribution for MC-simulated $e^+e^- \to \pi^+ D^0 D^{*-}$, $D^0 \to K^-\pi^+$ three-body phase-space events. Because of the limited phase space, some events from the isospin partner decay $\pi^+ Z_c(3885)^-$, $Z_c(3885)^- \to D^- D^{*0}$, where the detected D^0 is from the D^{*0} decay, also peak near $m_{D^{*-}}$, as shown by the dashed histogram for MC-simulated $e^+e^- \to \pi^+ Z_c(3885)^-$, $Z_c(3885)^- \to D^- D^{*0}$, $D^{*0} \to \gamma$ or $\pi^0 D^0$ decays with the mass and width of the $Z_c(3885)$ set to our final measured values. Since the $D\bar{D}^*$ invariant mass distribution is equivalent to the bachelor pion recoil mass spectrum, the shape of the $Z_c(3885) \to D\bar{D}^*$ signal peak is not sensitive to the parentage of the D meson that is used for the event tagging. Figure 1(b) shows the corresponding plot for $\pi^- D^+$-tag events, where the solid histogram shows the contribution from MC-simulated $e^+e^- \to \pi^- D^+ \bar{D}^{*0}$ three-body phase-space events and the dashed histogram shows the cross feed from MC-simulated $e^+e^- \to \pi^- Z_c(3885)^+$, $Z_c(3885)^+ \to \bar{D}^0 D^{*+}$, $D^{*+} \to \pi^0 D^+$ events.

We apply a two-constraint (2C) kinematic fit to the selected events that constrains the invariant mass of the D^0 (D^+) candidate to be equal to m_{D^0} (m_{D^+}) and the mass recoiling from the $\pi^+ D^0$ ($\pi^- D^+$) to be equal to $m_{D^{*-}}$ ($m_{\bar{D}^{*0}}$). If there is more than one bachelor pion candidate in an event, we retain the one with the smallest χ^2 from the 2C fit. Events with $\chi^2 < 30$ are retained for further analysis. For the $\pi^+ D^0$-tag analysis, we require $M(\pi^+ D^0) > 2.02$ GeV/c^2 to reject $e^+e^- \to D^{*+} D^{*-}$, $D^{*+} \to \pi^+ D^0$ events. Figure 2(a) [2(b)] shows the distribution of $D^0 D^{*-}$ ($D^+ \bar{D}^{*0}$) invariant masses recoiling from the bachelor pion for the $\pi^+ D^0$- ($\pi^- D^+$-) tag events. Both distributions have a distinct peak near the $m_D + m_{\bar{D}^*}$ mass threshold. For cross-feed events, the reconstructed D meson is not, in fact, recoiling from a $\bar{D}^*$, and the efficiency for these events decreases with increasing $D\bar{D}^*$ mass. This acceptance variation is not sufficient to produce a peaking

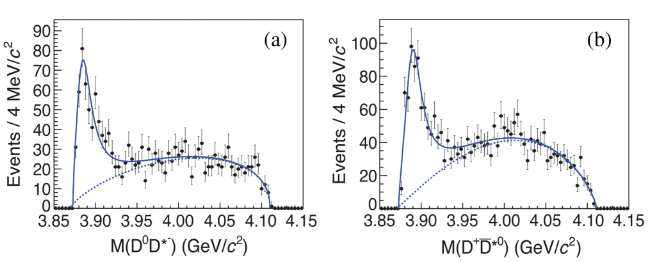

FIG. 2 (color online). The (a) $M(D^0 D^{*-})$ and (b) $M(D^+ \bar{D}^{*0})$ distributions for selected events. The curves are described in the text.

structure, and its influence on the signal parameter determination is small compared to other sources of systematic error.

To characterize the observed enhancement and determine the signal yield, we fit the histograms of Figs. 2(a) and 2(b) using a mass-dependent-width Breit-Wigner (BW) line shape using the parametrization described in Ref. [24] to model the signal and smooth threshold functions to represent the nonpeaking background. In the default fits, we assume S waves for $Z_c(3885)$ production and decay, and leave the $Z_c(3885)$ mass, width, and yield as free parameters. We multiply the BW by the mass-dependent efficiency to form the signal probability density function. Mass resolution effects are less than 1 MeV/c^2 and ignored. For the default nonpeaking background, we use: $f_{\rm bkg}(m_{D\bar{D}^*}) \propto (m_{D\bar{D}^*} - M_{\rm min})^c (M_{\rm max} - m_{D\bar{D}^*})^d$, where $M_{\rm min}$ and $M_{\rm max}$ are the minimum and maximum kinematically allowed masses, respectively, and c and d are free parameters.

The solid curves in Fig. 2 show the fit results and the dashed curves show the nonresonant background. The $Z_c(3885)$ signal significance for each fit is greater than 18σ. The fitted BW mass and width from the $\pi^+ D^0$ ($\pi^- D^+$)-tag sample are 3889.2 ± 1.8 MeV/c^2 and 28.1 ± 4.1 MeV (3891.8 ± 1.8 MeV/c^2 and 27.8 ± 3.9 MeV), respectively, where the errors are statistical only. Since the mass and width of a mass-dependent-width BW are model dependent [26], we solve for the corresponding complex quantities $P = M_{\rm pole} - i\Gamma_{\rm pole}/2$ for which the BW denominators are zero, and use $M_{\rm pole}$ and $\Gamma_{\rm pole}$ to characterize the $Z_c(3885)$. These are listed in Table I.

Monte Carlo studies indicate that the process $e^+e^- \to D\bar{D}_1(2420)$, $\bar{D}_1(2420) \to \bar{D}^*\pi$, where $D_1(2420)$ is the lightest established $D^*\pi$ resonance with $M_{D_1} = 2421.3 \pm 0.6$ MeV/c^2 and $\Gamma_{D_1} = 27.1 \pm 2.7$ MeV [6], would produce a near-threshold reflection peak in the $D\bar{D}^*$ mass distribution. The $D_1(2420)$ peak mass is 30 MeV/c^2 above the $\sqrt{s} - m_D$ kinematic boundary, which suggests that contributions from $D\bar{D}_1(2420)$ final states would be small. However, some models for the $Y(4260)$ attribute it to a bound $D\bar{D}_1$ molecular state [13], in which case subthreshold $\bar{D}_1 \to \bar{D}^*\pi$ decays might be important and, possibly, produce a reflection peak in the $D\bar{D}^*$ mass distribution that mimics a $Z_c(3885)$ signal.

We study this possibility by separating the events into two samples according to $|\cos\theta_{\pi D}| > 0.5$ and

TABLE I. The pole mass $M_{\rm pole}$ and width $\Gamma_{\rm pole}$, signal yields and fit quality (χ^2/ndf) for the two tag samples.

Tag	$M_{\rm pole}$ (MeV/c^2)	$\Gamma_{\rm pole}$ (MeV)	Z_c signal (evts)	χ^2/ndf
$\pi^+ D^0$	3882.3 ± 1.5	24.6 ± 3.3	502 ± 41	54/54
$\pi^- D^+$	3885.5 ± 1.5	24.9 ± 3.2	710 ± 54	60/54

$|\cos\theta_{\pi D}| < 0.5$, where $\theta_{\pi D}$ is the angle between the bachelor pion and the D meson directions in the $Z_c(3885)$ rest frame. For $D\bar{D}_1$ MC events, the asymmetry, $\mathcal{A} = (n_{>0.5} - n_{<0.5})/(n_{>0.5} + n_{<0.5})$ where $n_{>0.5}$ and $n_{<0.5}$ are the numbers of $Z_c(3885)$ signal events in each sample, is $\mathcal{A}_{\rm MC}^{D\bar{D}_1} = 0.43 \pm 0.04$, while for $e^+e^- \to \pi Z_c(3885)$ signal MC events it is $\mathcal{A}_{\rm MC}^{\pi Z_c} = 0.02 \pm 0.02$. For data, $\mathcal{A}_{\rm data} = 0.12 \pm 0.06$, close to the $e^+e^- \to \pi Z_c(3885)$ MC result and well below expectations for $D\bar{D}_1$ events. We conclude that the $D\bar{D}_1$ contribution to our observed signal yield is smaller than its assigned systematic error.

If the $Z_c(3885)$ quantum numbers are $J^P = 1^+$, the π-$Z_c(3885)$ system produced via $Y(4260) \to \pi Z_c(3885)$ can be in an S and/or a D wave. Since the process occurs near threshold, the D wave should be suppressed and $dN/d|\cos\theta_\pi| \simeq$ constant, where θ_π is the pion's polar angle relative to the beam direction in the e^+e^- rest frame. For $J^P = 0^-$ (1^-), the π-$Z_c(3885)$ would be in a P wave with an expected distribution of $dN/d|\cos\theta_\pi| \propto \sin^2\theta_\pi$ ($1 + \cos^2\theta_\pi$). Parity conservation excludes $J^P = 0^+$.

Figure 3 shows the efficiency-corrected fractional $Z_c(3885)$ signal yield for four bins of $|\cos\theta_\pi|$ with curves that show fit results for the $J^P = 1^+, 0^-$ and 1^- hypotheses. The data strongly prefer $J^P = 1^+$, with $\chi^2/\text{ndf} = 0.44/3$, and disagree with expectations for $J^P = 0^-$ ($\chi^2/\text{ndf} = 32/3$) and 1^- ($\chi^2/\text{ndf} = 16/3$).

We use the fitted numbers of signal events for the π^+D^0-tag and π^-D^+-tag samples, $N_{\pi^+}(Z_c(3885)^- \to (D\bar{D}^*)^-)$ and $N_{\pi^-}(Z_c(3885)^+ \to (D\bar{D}^*)^+)$, to make two independent measurements of the product cross section and branching fraction $\sigma(e^+e^- \to \pi Z_c(3885)) \times \mathcal{B}(Z_c(3885) \to D\bar{D}^*)$. We assume isospin symmetry and, for the π^+D^0-tag channel, determine

$$\sigma(e^+e^- \to \pi^\pm Z_c(3885)^\mp)\mathcal{B}(Z_c(3885)^\mp \to (D\bar{D}^*)^\mp) = \frac{N_{\pi^+}(Z_c(3885)^- \to (D\bar{D}^*)^-)}{\mathcal{L}(1+\delta)\mathcal{B}_{D^0\to K^-\pi^+}(\epsilon_1^0 + \epsilon_2^0)/2} = 84.6 \pm 6.9\ \text{pb}, \quad (1)$$

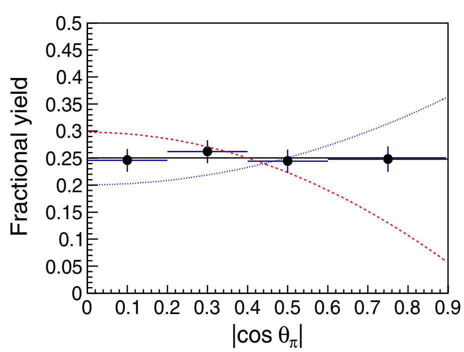

FIG. 3 (color online). $(1/N_{\rm tot})dN/d|\cos\theta_\pi|$ versus $|\cos\theta_\pi|$ for $Z_c(3885)$ events in data. The solid, dashed, and dotted curves show expectations for $J^P = 1^+$, 0^-, and 1^-, respectively.

where $\mathcal{L} = 525 \pm 5\ \text{pb}^{-1}$ is the integrated luminosity, $(1+\delta) = 0.87 \pm 0.04$ is the radiative correction factor [27], $\epsilon_1^0 = 0.46$ is the efficiency for $\pi^+Z_c(3885)^- \to \pi^+D^0D^{*-}$ MC events, $\epsilon_2^0 = 0.21$ is the efficiency for $\pi^+Z_c(3885)^- \to \pi^+D^-D^{*0}$, $D^{*0} \to \gamma/\pi^0D^0$ MC events, and the error is statistical.

For the π^-D^+-tag channel, we find

$$\sigma(e^+e^- \to \pi^\mp Z_c(3885)^\pm)\mathcal{B}(Z_c(3885)^\pm \to (D\bar{D}^*)^\pm) = \frac{N_{\pi^-}(Z_c(3885)^+ \to (D\bar{D}^*)^+)}{\mathcal{L}(1+\delta)\mathcal{B}_{D^+\to K^-\pi^+\pi^+}(\epsilon_1^+ + \epsilon_2^+\mathcal{B}_{D^{*+}\to\pi^0D^+})/2} = 82.3 \pm 6.3\ \text{pb}, \quad (2)$$

where $\epsilon_1^+ = 0.34$ is the efficiency for $\pi^-Z_c(3885)^+ \to \pi^-D^+\bar{D}^{*0}$ MC events, $\epsilon_2^+ = 0.24$ is the efficiency for $\pi^-Z_c(3885)^+ \to \pi^-\bar{D}^0D^{*+}$, $D^{*+} \to \pi^0D^+$ MC events, and the error is statistical. Agreement with the π^+D^0-tag result justifies the isospin invariance assumption.

The contributions from different sources of systematic errors are summarized in Table II. For cases where the systematic errors for the π^+D^0- and π^-D^+-tag samples are different, both results are listed. The acceptance uncertainty includes data-MC differences in BESIII tracking and particle ID efficiencies (both 1% per track) and the efficiency variation over the $Z_c(3885)$ mass uncertainty range. The uncertainties from D selection and the 2C fit are determined from a $e^+e^- \to D^{*+}D^{*-}$ control sample with the same final state as $\pi^+D^0D^{*-}$ signal events. The luminosity error is 1% [11] and that for $(1+\delta)$ is 5% [27]. For the signal shape error, we use differences between values from the default fit and those determined from fits with a mass-independent-width BW line shape. The largest contributions to the systematic errors are related to the choice of background shape. For this, we compare the default results with those that use a symmetric threshold function ($f_{\rm bkg}$ with $c = d$) (-24%) and the form $f_{\rm bkg}(x) \propto [(x - M_{\rm min})^{1/2} + c(x - M_{\rm min})^{3/2}] \times [(M_{\rm max} - x)^{1/2} + d(M_{\rm max} - x)^{3/2}]$ with c and d as free parameters ($+23\%$). We assume that

TABLE II. Contributions to systematic errors on the pole mass, pole width and signal yield. When two values are listed, the first is for π^+D^0 tags and the second for π^-D^+ tags.

Source	$M_{\rm pole}$ (MeV/c^2)	$\Gamma_{\rm pole}$ (MeV)	$\sigma \times \mathcal{B}$ (%)
Acceptance			± 7
D mass req.			± 1
D^0/D^+ branching fractions			± 1
Kinematic fit			± 4
Signal BW shape	$\pm 1/2$	± 3	± 5
Bkgd shape	$\pm 4.0/3.8$	$\pm 10.4/10.7$	± 24
$\mathcal{L}(1+\delta)$			± 5
Sum in quadrature	$\pm 4.1/4.3$	$\pm 10.8/11.1$	± 26.3

TABLE III. Parameters for the $Z_c(3885) \to D\bar{D}^*$ reported here and those for the $Z_c(3900) \to \pi J/\psi$ taken from Ref. [11].

	$Z_c(3885) \to D\bar{D}^*$	$Z_c(3900) \to \pi J/\psi$
Mass (MeV/c^2)	$3883.9 \pm 1.5 \pm 4.2$	$3899.0 \pm 3.6 \pm 4.9$
Γ (MeV)	$24.8 \pm 3.3 \pm 11.0$	$46 \pm 10 \pm 20$
$\sigma \times \mathcal{B}$ (pb)	$83.5 \pm 6.6 \pm 22.0$	$13.5 \pm 2.1 \pm 4.8$

the errors from the different sources are uncorrelated and use the sums in quadrature as the total systematic errors.

The fits reported here assume that the $Z_c(3885)$ is produced in, and decays into, S-wave states. Attempts to fit the peak with P-wave line shapes, both for production and decay, fail to converge. This compatibility with the S wave is consistent with the observed $\cos\theta_\pi$ distribution.

For the final mass, width, and cross section values, we use weighted averages of the results from the two tag modes, with the near-complete correlations between the systematic errors taken into account. The results are listed in Table III, where we also include results for the $Z_c(3900) \to \pi J/\psi$ taken from Ref. [11] for comparison. When statistical and systematic errors are added in quadrature, the $Z_c(3885)$ mass is about 2σ lower and the width 1σ lower than the $Z_c(3900)$ values.

In summary, we report observation of a strong threshold enhancement, $Z_c(3885)$, in the $D\bar{D}^*$ invariant mass distribution in the process $e^+e^- \to \pi^\pm(D\bar{D}^*)^\mp$ at $\sqrt{s} = 4.26$ GeV. The signal line shape and $|\cos\theta_\pi|$ distributions agree with expectations for a $J^P = 1^+$ quantum number assignment. Other $J \le 1$ assignments are eliminated.

An important question is whether or not the source of the $Z_c(3885) \to D\bar{D}^*$ structure is the same as that for the $Z_c(3900) \to \pi J/\psi$. The fitted $Z_c(3885)$ mass is marginally inconsistent with that of the $Z_c(3900)$ [11,12]. A J^P quantum number determination of the $Z_c(3900)^\pm$ would provide an additional test of this possibility.

Assuming the $Z_c(3885)$ structure reported here is due to the $Z_c(3900)$, the ratio of partial decay widths is determined to be $(\Gamma(Z_c(3885) \to D\bar{D}^*)/\Gamma(Z_c(3900) \to \pi J/\psi)) = 6.2 \pm 1.1 \pm 2.7$. This ratio is much smaller than typical values for decays of conventional charmonium states above the open charm threshold. For example: $\Gamma(\psi(3770) \to D\bar{D})/\Gamma(\psi(3770) \to \pi^+\pi^- J/\psi) = 482 \pm 84$ [6] and $\Gamma(\psi(4040) \to D^{(*)}\bar{D}^{(*)})/\Gamma(\psi(4040) \to \eta J/\psi) = 192 \pm 27$ [25]. This suggests the influence of very different dynamics in the $Y(4260)$-$Z_c(3900)$ system.

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