Observation of a Neutral Structure near the DD[over ¯]^{*} Mass Threshold in e^{+}e^{-}→(DD[over ¯]^{*})^{0}π^{0} at sqrt[s]=4.226 and 4.257 GeV

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Observation of a neutral structure near the $D\bar{D}^*$ mass threshold in $e^+e^- \to (D\bar{D}^*)^0\pi^0$ at $\sqrt{s} = 4.226$ and 4.257 GeV

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A neutral structure in the $D\bar{D}^*$ system around the $D\bar{D}^*$ mass threshold is observed with a statistical significance greater than 10σ in the processes $e^+e^- \to D^+D^{*-}\pi^0 + c.c.$ and $e^+e^- \to D^0\bar{D}^{*0}\pi^0 + c.c.$ at $\sqrt{s} = 4.226$ and 4.257 GeV in the BESIII experiment. The structure is denoted as $Z_c(3885)^0$. Assuming the presence of a resonance, its pole mass and width are determined to be $(3885.7^{+4.3}_{-5.7}(\text{stat.})\pm 8.4(\text{syst.}))$ MeV/c^2 and $(35^{+11}_{-12}(\text{stat.})\pm 15(\text{syst.}))$ MeV, respectively. The Born cross sections are measured to be $\sigma(e^+e^- \to Z_c(3885)^0\pi^0, Z_c(3885)^0 \to D\bar{D}^*) = (77 \pm 13(\text{stat.})\pm 17(\text{syst.}))$ pb at 4.226 GeV and $(47 \pm 9(\text{stat.})\pm 10(\text{syst.}))$ pb at 4.257 GeV. The ratio of decay rates $\frac{\mathcal{B}(Z_c(3885)^0 \to D^+D^{*-}+c.c.)}{\mathcal{B}(Z_c(3885)^0 \to D^0\bar{D}^{*0}+c.c.)}$ is determined to be $0.96 \pm 0.18(\text{stat.})\pm 0.12(\text{syst.})$, consistent with no isospin violation in the process $Z_c(3885)^0 \to D\bar{D}^*$.

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The existence of exotic states beyond those of conventional mesons and baryons was debated for decades, mostly because no convincing experimental evidence for them had been found [1]. In recent years, the discovery of charged Z_c charmonium-like states [2, 3], which decay to a charmonium state plus a pion or a pair of charmed mesons and, therefore, must consist of at least a four constituent quark configuration $c\bar{c}q\bar{q}'$, has stirred excitement about these possible exotic states. In $e^+e^- \to \pi^\mp Z_c^\pm$ processes, four $Z_c^\pm$ states have been discovered in the decays of $Z_c(3885)^\pm \to (D\bar{D}^*)^\pm$ [4, 5], $Z_c(3900)^\pm \to \pi^\pm J/\psi$ [6–8], $Z_c(4020)^\pm \to \pi^\pm h_c$ [9] and $Z_c(4025)^\pm \to (D^*\bar{D}^*)^\pm$ [10]. There have been many theoretical predictions and interpretations [3] to explain their nature as exotic mesons. However, none of these models have either been ruled out or established experimentally.

After the discoveries of the charged $Z_c^\pm$ states, BESIII reported studies of their neutral partners in the isospin symmetric channel of $e^+e^- \to \pi^0 Z_c^0$. A $Z_c(3900)^0$ is found in $e^+e^- \to \pi^0\pi^0 J/\psi$ [11], a $Z_c(4020)^0$ in $e^+e^- \to \pi^0\pi^0 h_c$ [12] and a $Z_c(4025)^0$ in $e^+e^- \to \pi^0(D^*\bar{D}^*)^0$ [13]. Evidence for $Z_c(3900)^0$ in $e^+e^- \to \pi^0 Z_c^0$ was previously reported with CLEO-c data at $\sqrt{s} = 4.17$ GeV [8]. These measurements indicate that the $Z_c(3900)$, $Z_c(4020)$ and $Z_c(4025)$ are three different isospin triplet states, since their relative Born cross sections of the charged modes to the neutral modes are compatible with isospin conservation. This motivates a search for the neutral partner of the $Z_c(3885)^\pm$ in $e^+e^- \to (D\bar{D}^*)^0\pi^0 + c.c.$ to identify its isospin.

In this Letter, the process $e^+e^- \to (D\bar{D}^*)^0\pi^0 + c.c.$ is studied, where $(D\bar{D}^*)^0$ refers to D^+D^{*-} or $D^0\bar{D}^{*0}$. A neutral charmonium-like structure, the $Z_c(3885)^0$, is observed around the $(D\bar{D}^*)^0$ mass threshold in the $(D\bar{D}^*)^0$ mass spectrum. This analysis is based on data samples collected by the BESIII detector with integrated luminosities of 1092 pb^{-1} at $\sqrt{s} = 4.226$ GeV and 826 pb^{-1} at $\sqrt{s}$ =4.257 GeV [14, 15]. Note that charge conjugation is always implied, unless explicitly stated.

BESIII [16] is a general-purpose detector at the double-ring e^+e^- collider BEPCII, which is used for the study of physics in the τ-charm energy region [17]. Monte Carlo (MC) simulations based on GEANT4 [18] are implemented in the BESIII experiment. For each energy point, we generate a signal MC sample based on the Covariant Tensor Amplitude Formalism [19] to simulate the S-wave process $e^+e^- \to Z_c^0\pi^0 \to (D\bar{D}^*)^0\pi^0$, assuming that the Z_c^0 has $J^P = 1^+$. Effects of initial state radiation (ISR) are taken into account with the MC event generator KKMC [20, 21], where the line shape of the Born cross section of $e^+e^- \to Z_c^0\pi^0 \to (D\bar{D}^*)^0\pi^0$ is assumed to follow that of the charged channel $e^+e^- \to Z_c^\pm\pi^\mp \to (D\bar{D}^*)^\pm\pi^\mp$ [4]. In addition, a large statistics MC sample of the three body process $e^+e^- \to (D\bar{D}^*)^0\pi^0$ is generated according to phase space (PHSP). To study possible backgrounds, MC simulations of $Y(4260)$ generic decays, ISR production of the vector charmonium states, charmed meson production and the continuum process $e^+e^- \to q\bar{q}$ ($q = u,\ d,\ s$) equivalent to 10 times the luminosity of the data at $\sqrt{s} = 4.226$ and 4.257 GeV are generated. Particle decays are simulated with EVTGEN [22, 23] for the known decay modes with branching fractions set to the world average [1] and with the LUNDCHARM model [24] for the remaining unknown decays.

In this work, we study $e^+e^- \to D^+D^{*-}\pi^0$, $D^{*-} \to \bar{D}^0\pi^-$ based on the detection of the $D^+\bar{D}^0$ pair and $e^+e^- \to D^0\bar{D}^{*0}\pi^0$, $\bar{D}^{*0} \to \bar{D}^0\pi^0$ based on the detection of the $D^0\bar{D}^0$ pair. The $D\bar{D}$ meson pairs are reconstructed through five hadronic decay modes $K^-\pi^+\pi^+, K^-\pi^+\pi^+\pi^0, K_S\pi^+, K_S\pi^+\pi^0, K_S\pi^+\pi^+\pi^-$ for the D^+ and three modes $K^+\pi^-$, $K^+\pi^-\pi^0$, $K^+\pi^+\pi^+\pi^-$ for the $\bar{D}^0$. The primary π^0, which is produced along with the $D\bar{D}^*$ in the e^+e^- reaction, is reconstructed from a pair of photons, while the soft π from the D^* decay is not required to improve the detection efficiency. The D^+D^- mode is not included because of its low rate compared to $D^0\bar{D}^0$ and $D^+\bar{D}^0$.

In this analysis, the selection criteria in Ref. [5] are used to identify the $\pi^\pm/K^\pm$, photon, π^0 and K_S candidates. The charged-particle tracks in each D candidate are constrained to a common vertex, except for those from K_S decays, and the χ^2 of the vertex fit is required to be less than 100. Each D candidate is required to have its reconstructed invariant mass in the range (1.840, 1.880) GeV/c^2. Furthermore, a mass-constrained kinematic fit (KF) to the nominal D mass is performed, and the KF chisquare χ^2_D is required to be less than 100. In case there is more than one $D\bar{D}$ combination in an event, only the candidate with the minimum sum of $\chi^2_D + \chi^2_{\bar{D}}$ is kept. The $D\bar{D}$ four-momenta from the mass-constrained KF are used for the further analysis.

The primary π^0 candidates are reconstructed with pairs of photons which are not used in forming the $D\bar{D}$ mesons, and their invariant masses $M(\gamma\gamma)$ must be in the range $(0.120, 0.150)$ GeV/c^2. To reduce backgrounds and to improve the resolution, a KF with two degrees of freedom (2C) is performed, constraining $M(\gamma\gamma)$ to the nominal π^0 mass $m(\pi^0)$ and the recoil mass of $\pi^0 D\bar{D}$, $RM(\pi^0 D\bar{D})$, to the nominal π mass. The 2C KF chisquare $\chi^2_{2\mathrm{C}}(\pi)$ must be less than 200. For each $D\bar{D}$ mode, if there is more than one primary π^0 candidate, the one with the minimum $\chi^2_{2\mathrm{C}}(\pi)$ is retained for further analysis. For $e^+e^- \to D^0\bar{D}^{*0}\pi^0$ with $\bar{D}^{*0} \to \bar{D}^0\pi^0$, the process $e^+e^- \to D^0\bar{D}^{*0}\pi^0$ with $\bar{D}^{*0} \to \bar{D}^0\gamma$ is a major background. To reject this background, we require $\chi^2_{2\mathrm{C}}(\pi^0) < 60$. We also perform a similar 2C KF but constrain $RM(\pi^0 D^0\bar{D}^0)$ to be zero, which corresponds to the mass of the photon in $\bar{D}^{*0} \to \bar{D}^0\gamma$, and the corresponding fit chisquare is required to satisfy $\chi^2_{2\mathrm{C}}(\gamma) > 20$ to further suppress this background. The fitted four-momentum of the primary π^0 is used in the next stage of the analysis.

In the surviving events, the occurrence of multiple $(D\bar{D}^*)^0\pi^0$ combinations per event is negligible. To help separate the signal events, we require $M(D^+\pi^0) > 2.1$ GeV/c^2 and $M(D^0\pi^0) > 2.1$ GeV/c^2 [25]. Due to the limited phase space, the invariant mass of $D^+\pi^0(D^0\pi^0)$ and that of $\bar{D}^0\pi^0$ are highly correlated, and the background with the selected π^0 and $\bar{D}^0$ from the $\bar{D}^{*0}$ decay is suppressed by the above selection criteria, too. The $RM(D\pi^0)$ distributions are illustrated in Fig. 1, where clear peaks are seen over simulated backgrounds around the $m(D^*)$ position. These peaks correspond to the final states of $(D\bar{D}^*)^0\pi^0$. We further require events to be within the mass window $|RM(D\pi^0) - m(D^*)| < 36$ MeV/c^2 for the final analysis.

The $M(D\bar{D}^*)$ distribution of the surviving events is plotted in Fig. 2. An enhancement near the $D\bar{D}^*$ mass threshold around 3.9 GeV/c^2 is visible, which is seen in both $D^+D^{*-}\pi^0$ and $D^0\bar{D}^{*0}\pi^0$ at $\sqrt{s} = 4.226$ and 4.257 GeV. As verified in MC simulations, these structures cannot be attributed to the $e^+e^- \to (D\bar{D}^*)^0\pi^0$ three body PHSP or inclusive MC background. Possible backgrounds from $e^+e^- \to D^{(*)}\bar{D}^{**} \to D\bar{D}^*\pi$ have been studied. Most of them, such as $D^*\bar{D}^*(2400)$, $D\bar{D}^*(2460)$ and $D^*\bar{D}^*(2420)$ cannot contribute to the selected events since their mass thresholds are higher than 4.26 GeV/c^2. The only possible peaking background $e^+e^- \to D^{(*)}\bar{D}_1(2420)$ has been studied in Ref. [5], and its contribution is found to be negligible.

Assuming that there is a resonant structure close to the $D\bar{D}^*$ mass threshold (labeled as $Z_c(3885)^0$), we model

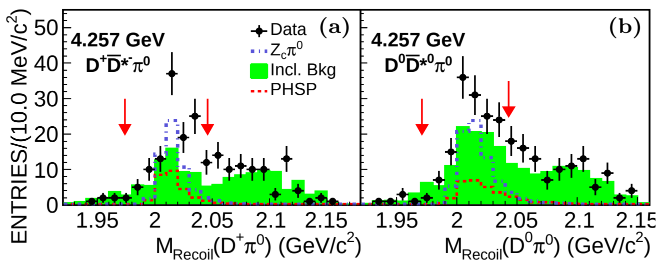

FIG. 1. Distributions of $RM(D\pi^0)$ at $\sqrt{s} = 4.257$ GeV. The signal and phase space (PHSP) processes are overlaid with an arbitrary scale. The solid arrows indicate the selection criteria for the $(D\bar{D}^*)^0\pi^0$ candidates. Data at $\sqrt{s} = 4.226$ GeV show similar distributions and are omitted.

its line shape using a relativistic S-wave Breit-Wigner function with a mass-dependent width multiplied with a phase space factor q

$$\left| \frac{\sqrt{M\Gamma_I(M)/c^2}}{M^2 - m^2 + iM(\Gamma_1(M) + \Gamma_2(M))/c^2} \right|^2 \cdot q \quad (I = 1, 2),$$

where $\Gamma_I(M) = \Gamma_I \cdot (m/M) \cdot (p^*_I/p^0_I)$. I denotes the different decay modes, where $I = 1$ represents the D^+D^{*-} decay mode and $I = 2$ represents the $D^0\bar{D}^{*0}$ decay mode. M is the reconstructed mass, m is the nominal resonance mass and Γ_I is the partial width of the decay channel I. Under the assumption of isospin symmetry, we take Γ_I to be half of the full width Γ, assuming that the decay rates to other possible coupled channels are negligible. $p^*_I(q)$ is the momentum of the $D(\pi^0)$ in the rest frame of the $D\bar{D}^*$ system (the initial e^+e^- system), and p^0_I is the momentum of the D in the resonance rest frame at $M = m$.

An unbinned maximum likelihood fit is performed on the $M(D\bar{D}^*)$ spectra for $e^+e^- \to (D\bar{D}^*)^0\pi^0$ simultaneously at $\sqrt{s} = 4.226$ and 4.257 GeV. Three components are included in the fits: the $Z_c(3885)^0$ signal, the PHSP processes and MC simulated backgrounds. The signal shape is described as a mass-dependent-efficiency weighted Breit-Wigner function, described above, convoluted with the experimental resolution function. The resolution function and the efficiency shape are obtained from MC simulations. The shape of the PHSP processes is derived from MC simulations, and their amplitudes are allowed to vary in the fits. The inclusive MC background distributions are modeled based on the kernel estimation [26], and their sizes are fixed according to the expected numbers estimated in the inclusive MC samples. The simulated backgrounds are validated by comparing their $M(D\pi^0)$ and $RM(D\pi^0)$ distributions with those for data in sideband regions $(1.920, 1.974) \cup (2.090, 2.180)$ GeV/c^2 for the $D^+\bar{D}^0$ mode and $(1.920, 1.971) \cup (2.090, 2.160)$ GeV/c^2 for the $D^0\bar{D}^0$ mode.

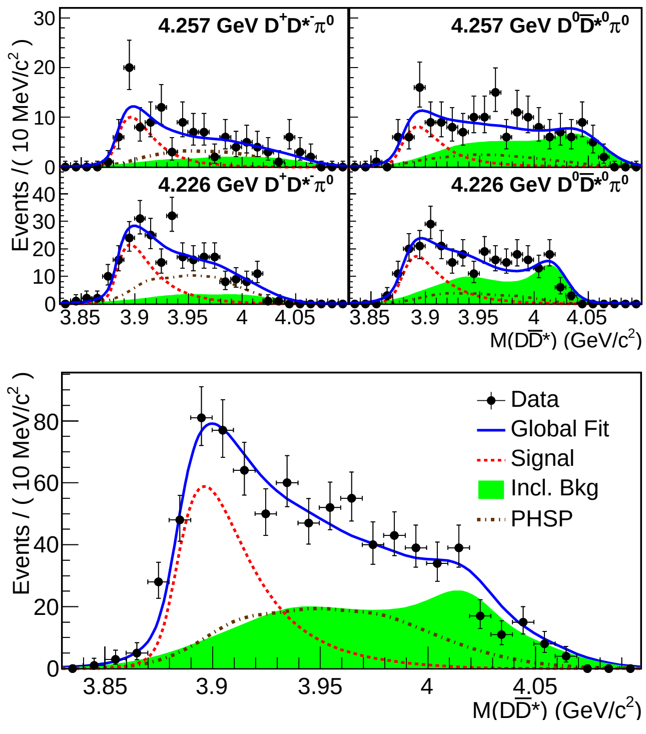

FIG. 2. (Upper) Projections of the simultaneous fit to the $M(D\bar{D}^*)$ spectra for $e^+e^- \to D^+D^{*-}\pi^0$ and $D^0\bar{D}^{*0}\pi^0$ at $\sqrt{s}$ = 4.226 and 4.257 GeV. (Lower) Sum of the simultaneous fit to the $M(D\bar{D}^*)$ spectra for different decay modes at the different energy points above.

We define the ratio $\mathcal{R} = \mathcal{B}_{D^+D^{*-}}/\mathcal{B}_{D^0\bar{D}^{*0}}$, where $\mathcal{B}_{D^+D^{*-}}(\mathcal{B}_{D^0\bar{D}^{*0}})$ is the branching ratio of $Z_c(3885)^0 \to D^+D^{*-}(D^0\bar{D}^{*0})$. In the fit, $\mathcal{R}$ is assumed to be same for the data at $\sqrt{s}$ = 4.226 and 4.257 GeV. The number of observed signal events, $N_{\rm obs}$, is given by $N_{\rm obs} = \mathcal{L}\sigma_{D\bar{D}^*}(1+\delta^{\rm rad})(1+\delta^{\rm vac})\varepsilon\mathcal{B}_{\rm int}$, where $\sigma_{D\bar{D}^*}$ is the Born cross section $\sigma(e^+e^- \to Z_c(3885)^0\pi^0, Z_c(3885)^0 \to D\bar{D}^*)$, $\mathcal{L}$ is the integrated luminosity, $(1+\delta^{\rm rad})$ is the initial radiative correction factor, $(1+\delta^{\rm vac})$ is the vacuum polarization factor [27], ε is the detection efficiency and $\mathcal{B}_{\rm int}$ is the product of the decay rates of the intermediate states.

Figure 2 shows the fit results. To assess the goodness of fit, we bin the dataset in 19 bins such that each bin contains at least 10 events, and compute the χ^2 between the binned data and the projection of the fit. We find χ^2/d.o.f. = 18.5/19 for the simultaneous fit in the lower plot. The statistical significance of the $Z_c(3885)^0$ signal is estimated to be more than 12σ, based on the difference of the maximized likelihoods between the fit with and without including the signal component. The mass and width of the $Z_c(3885)^0$ are measured to be $m(Z_c(3885)^0) = (3894.7 \pm 3.0)$ MeV/c^2 and $\Gamma(Z_c(3885)^0) = (36 \pm 17)$ MeV. The corresponding pole mass and width are calculated to be $m_{\rm pole}(Z_c(3885)^0) = 3885.7^{+4.3}_{-5.7}$ MeV/c^2 and $\Gamma_{\rm pole}(Z_c(3885)^0) = 35^{+11}_{-12}$ MeV [28]. From the fit, we determine $\sigma_{D\bar{D}^*}$ to be (77 ± 13) pb and (47 ± 9) pb at $\sqrt{s}$ = 4.226 and 4.257 GeV, respectively. We also obtain $\mathcal{R} = 0.96 \pm 0.18$.

TABLE I. Summary of systematic uncertainties for the resonance parameters, the Born cross sections and the ratio of decay rates. Values outside the parenthesis represents uncertainties for $\sigma_{D\bar{D}^*}$ at $\sqrt{s}$ = 4.226 GeV, while those inside are for $\sigma_{D\bar{D}^*}$ at $\sqrt{s}$ = 4.257 GeV. The total systematic uncertainties are obtained by combining all the independent sources in quadrature.

Source	$m_{\rm pole}$(MeV/c^2)	$\Gamma_{\rm pole}$(MeV)	$\sigma_{D\bar{D}^*}$(%)	$\mathcal{R}$(%)
Beam energy	1.0	3.0	4 (5)	1
Signal shape	3.5	8.2	5 (4)	2
Background	6.8	6.6	15 (15)	4
Fit range	0.3	0.3	3 (1)	1
Mass shift	3.0			
Resolution		9.5	11 (4)	1
Efficiency			11 (11)	11
Input-output check	1.6	2.5		
$(1+\delta^{\rm rad})(1+\delta^{\rm vac})$			5 (5)	
$\mathcal{B}_{\rm int}$			5 (5)	5
$\mathcal{L}$			1 (1)	
Total	8.4	15	23 (21)	13

The systematic uncertainties on the measurements of the $Z_c(3885)^0$ resonance parameters, the cross section $\sigma_{D\bar{D}^*}$ and the ratio $\mathcal{R}$ are studied, and the major contributions are summarized in Table I. The systematic uncertainties on the $Z_c(3885)^0$ resonance parameters mainly come from the signal shape, background, mass shift and detector resolution. The dominant systematic uncertainties on $\sigma_{D\bar{D}^*}$ and $\mathcal{R}$ are from the background, resolution and detection efficiency.

The uncertainty from the beam energy is estimated by varying the beam energy by ±1 MeV in the 2C KF, and the maximum differences of the mass, width, $\sigma_{D\bar{D}^*}$ at $\sqrt{s}$ =4.226 (4.257) GeV and $\mathcal{R}$ are found to be 1.0 MeV/c^2, 3.0 MeV, 5%(4%) and 1%, respectively. To assess the uncertainty of the signal shape, an S-wave relativistic Breit-Wigner function with constant width [28] is taken as an alternative signal model in the simultaneous fit. The changes of the fitted mass and width are determined to be 3.5 MeV/c^2 and 8.2 MeV, while the change on $\sigma_{D\bar{D}^*}$ is 5%(4%) at $\sqrt{s}$ =4.226 (4.257) GeV and on $\mathcal{R}$ 2%. The systematic uncertainty due to background description is estimated by leaving free the absolute numbers of the inclusive backgrounds in the fit, or adjusting their shapes by varying the scalings of different background components in the inclusive MC samples. Those fit results differ from the nominal results by 6.8 MeV/c^2 in mass, 6.6 MeV in width, 15% in $\sigma_{D\bar{D}^*}$ both at $\sqrt{s}$ =4.226 and 4.257 GeV, and 4% in $\mathcal{R}$. Maximum fluctuations due to changing the fit range are assigned as systematic uncertainties. The MC simulation of the mass shift and resolution may not fully reflect the effects in data, and it is studied by fitting the $\bar{D}^*$

peak in the $RM(D\pi^0)$ spectra to obtain the mass shift and the resolution difference between data and MC. The obtained mass shift is quoted as part of the systematic uncertainties of the mass. The variations of the fit results after considering the resolution difference is assigned as systematic uncertainty.

Efficiency-related systematic uncertainties are universal in each D decay mode and include six sources: tracking efficiency, particle identification, photon detection efficiency, π^0 reconstruction efficiency, K_S reconstruction efficiency and KF efficiency. The uncertainties of tracking efficiency and particle identification for $\pi^\pm$ and $K^\pm$ are evaluated to be 1% per track [29, 30]. The uncertainty in the photon-reconstruction efficiency is estimated to be about 1% per photon [31]. The efficiency difference of reconstructing the K_S in MC simulations and in data is 4.0% [32]. The uncertainty in π^0 reconstruction is 1% [31]. The systematic bias of the KF is estimated by using the track-parameter-correction method [33]. The correction factors for helix track parameters are determined from the control sample $e^+e^- \to K^*(892)^0K^+\pi^- \to K^+K^-\pi^+\pi^-$. The total efficiency-related systematic uncertainty is taken as the square root of the quadratic sum of the individual uncertainties. The potential bias from the event selection and the analysis procedure studied with input-output checks, which compare the output results with the input values of the resonance mass and width based on MC simulations. We assign the systematic uncertainty of 1.6 MeV/c^2 in mass and 2.5 MeV in width accordingly. The systematic uncertainty of the radiative correction factor $1+\delta^{\rm rad}$, which includes the effect on the detection efficiency, is estimated to be 5% by changing the input $(D\bar{D}^*)^0\pi^0$ line shape within errors [4]. The systematic uncertainty of the vacuum polarization factor $1+\delta^{\rm vac}$ is 0.5% taken from QED calculation [27]. The weighted systematic uncertainty of $\mathcal{B}_{\rm int}$ is from the world average value [1]. The uncertainty of integrated luminosity is taken as 1% by measuring Bhabha events [14]. The uncertainty of the mass window requirement is negligible. The overall systematic uncertainties are determined by combining all the sources in quadrature, assuming they are independent.

In summary, we study $e^+e^- \to D^+D^{*-}\pi^0 + c.c.$ and $e^+e^- \to D^0\bar{D}^{*0}\pi^0 + c.c.$ using data taken at $\sqrt{s} = 4.226$ and 4.257 GeV. A neutral structure around the $D\bar{D}^*$ mass threshold is observed with a statistical significance greater than 10σ. Assuming that it is a resonance, we model it with a relativistic Breit-Wigner function. Its pole mass and width are measured to be $(3885.7^{+4.3}_{-5.7}(\rm stat)\pm 8.4(\rm syst))$ MeV/c^2 and $(35^{+11}_{-12}(\rm stat)\pm 15(\rm syst))$ MeV, respectively, which are close to the mass and width of the reported charged $Z_c(3885)^+$ [4, 5]. The Born cross sections $\sigma(e^+e^- \to Z_c^0\pi^0 \to (D\bar{D}^*)^0\pi^0 + c.c.)$ are determined to be $(77\pm 13\pm 17)$ pb and $(47\pm 9\pm 10)$ pb at $\sqrt{s} = 4.226$ and 4.257 GeV, respectively, which are consistent with half of $\sigma(e^+e^- \to Z_c^+\pi^- \to (D\bar{D}^*)^+\pi^- + c.c.)$ [5]. A comparison between the resonance parameters of the $Z_c(3885)^+$ and the $Z_c(3885)^0$ is summarized in the Supplemental Material [25]. All these observations favor the assumption that the $Z_c(3885)^0$ is the neutral isospin partner of the $Z_c(3885)^\pm$, and the $Z_c(3885)^\pm/Z_c(3885)^0$ form an isospin triplet. In addition, we determine the ratio of the decay rate $\mathcal{R} = \frac{\mathcal{B}(Z_c(3885)^0 \to D^+D^{*-})}{\mathcal{B}(Z_c(3885)^0 \to D^0\bar{D}^{*0})} = 0.96\pm 0.18\pm 0.12$, which is consistent with unity. Hence, no isospin violation in the process $Z_c(3885)^0 \to D\bar{D}^*$ is observed.

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