CLEO CONF95-17
EPS0177
July 3, 1995

Observation of the Isospin-Violating Decay $D_s^{*+} \to D_s^+ \pi^0$

J. Gronberg,[1] C.M. Korte,[1] R. Kutschke,[1] S. Menary,[1] R.J. Morrison,[1] S. Nakanishi,[1] H.N. Nelson,[1] T.K. Nelson,[1] C. Qiao,[1] J.D. Richman,[1] D. Roberts,[1] A. Ryd,[1] H. Tajima,[1] M.S. Witherell,[1] R. Balest,[2] K. Cho,[2] W.T. Ford,[2] M. Lohner,[2] H. Park,[2] P. Rankin,[2] J.G. Smith,[2] J.P. Alexander,[3] C. Bebek,[3] B.E. Berger,[3] K. Berkelman,[3] K. Bloom,[3] T.E. Browder,[3*] D.G. Cassel,[3] H.A. Cho,[3] D.M. Coffman,[3] D.S. Crowcroft,[3] M. Dickson,[3] P.S. Drell,[3] D.J. Dumas,[3] R. Ehrlich,[3] R. Elia,[3] P. Gaidarev,[3] M. Garcia-Sciveres,[3] B. Gittelman,[3] S.W. Gray,[3] D.L. Hartill,[3] B.K. Heltsley,[3] S. Henderson,[3] C.D. Jones,[3] S.L. Jones,[3] J. Kandaswamy,[3] N. Katayama,[3] P.C. Kim,[3] D.L. Kreinick,[3] T. Lee,[3] Y. Liu,[3] G.S. Ludwig,[3] J. Masui,[3] J. Mevissen,[3] N.B. Mistry,[3] C.R. Ng,[3] E. Nordberg,[3] J.R. Patterson,[3] D. Peterson,[3] D. Riley,[3] A. Soffer,[3] P. Avery,[4] A. Freyberger,[4] K. Lingel,[4] C. Prescott,[4] J. Rodriguez,[4] S. Yang,[4] J. Yelton,[4] G. Brandenburg,[5] D. Cinabro,[5] T. Liu,[5] M. Saulnier,[5] R. Wilson,[5] H. Yamamoto,[5] T. Bergfeld,[6] B.I. Eisenstein,[6] J. Ernst,[6] G.E. Gladding,[6] G.D. Gollin,[6] M. Palmer,[6] M. Selen,[6] J.J. Thaler,[6] K.W. Edwards,[7] K.W. McLean,[7] M. Ogg,[7] A. Bellerive,[8] D.I. Britton,[8] E.R.F. Hyatt,[8] R. Janicek,[8] D.B. MacFarlane,[8] P.M. Patel,[8] B. Spaan,[8] A.J. Sadoff,[9] R. Ammar,[10] P. Baringer,[10] A. Bean,[10] D. Besson,[10] D. Coppage,[10] N. Copty,[10] R. Davis,[10] N. Hancock,[10] S. Kotov,[10] I. Kravchenko,[10] N. Kwak,[10] Y. Kubota,[11] M. Lattery,[11] M. Momayezi,[11] J.K. Nelson,[11] S. Patton,[11] R. Poling,[11] V. Savinov,[11] S. Schrenk,[11] R. Wang,[11] M.S. Alam,[12] I.J. Kim,[12] Z. Ling,[12] A.H. Mahmood,[12] J.J. O'Neill,[12] H. Severini,[12] C.R. Sun,[12] F. Wappler,[12] G. Crawford,[13] R. Fulton,[13] D. Fujino,[13] K.K. Gan,[13] K. Honscheid,[13] H. Kagan,[13] R. Kass,[13] J. Lee,[13] M. Sung,[13] C. White,[13] A. Wolf,[13] M.M. Zoeller,[13] X. Fu,[14] B. Nemati,[14] W.R. Ross,[14] P. Skubic,[14] M. Wood,[14] M. Bishai,[15] J. Fast,[15] E. Gerndt,[15] J.W. Hinson,[15] T. Miao,[15] D.H. Miller,[15] M. Modesitt,[15] E.I. Shibata,[15] I.P.J. Shipsey,[15] P.N. Wang,[15] L. Gibbons,[16] S.D. Johnson,[16] Y. Kwon,[16] S. Roberts,[16] E.H. Thorndike,[16] T.E. Coan,[17] J. Dominick,[17] V. Fadeyev,[17] I. Korolkov,[17] M. Lambrecht,[17] S. Sanghera,[17] V. Shelkov,[17] T. Skwarnicki,[17] R. Stroynowski,[17] I. Volobouev,[17] G. Wei,[17] M. Artuso,[18] M. Gao,[18] M. Goldberg,[18] D. He,[18] N. Horwitz,[18] S. Kopp,[18] G.C. Moneti,[18] R. Mountain,[18] F. Muheim,[18] Y. Mukhin,[18] S. Playfer,[18] S. Stone,[18] X. Xing,[18] J. Bartelt,[19] S.E. Csorna,[19] V. Jain,[19] S. Marka,[19] D. Gibaut,[20] K. Kinoshita,[20] P. Pomianowski,[20] B. Barish,[21] M. Chadha,[21] S. Chan,[21] D.F. Cowen,[21] G. Eigen,[21] J.S. Miller,[21] C. O'Grady,[21] J. Urheim,[21] A.J. Weinstein,[21] F. Würthwein,[21] D.M. Asner,[22] M. Athanas,[22] D.W. Bliss,[22] W.S. Brower,[22] G. Masek,[22] and H.P. Paar[22]

(CLEO Collaboration)

[1] *University of California, Santa Barbara, California 93106*
[2] *University of Colorado, Boulder, Colorado 80309-0390*
[3] *Cornell University, Ithaca, New York 14853*
[4] *University of Florida, Gainesville, Florida 32611*
[5] *Harvard University, Cambridge, Massachusetts 02138*
[6] *University of Illinois, Champaign-Urbana, Illinois, 61801*
[7] *Carleton University, Ottawa, Ontario K1S 5B6 and the Institute of Particle Physics, Canada*
[8] *McGill University, Montréal, Québec H3A 2T8 and the Institute of Particle Physics, Canada*
[9] *Ithaca College, Ithaca, New York 14850*
[10] *University of Kansas, Lawrence, Kansas 66045*
[11] *University of Minnesota, Minneapolis, Minnesota 55455*
[12] *State University of New York at Albany, Albany, New York 12222*
[13] *Ohio State University, Columbus, Ohio, 43210*
[14] *University of Oklahoma, Norman, Oklahoma 73019*
[15] *Purdue University, West Lafayette, Indiana 47907*
[16] *University of Rochester, Rochester, New York 14627*
[17] *Southern Methodist University, Dallas, Texas 75275*
[18] *Syracuse University, Syracuse, New York 13244*
[19] *Vanderbilt University, Nashville, Tennessee 37235*
[20] *Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061*
[21] *California Institute of Technology, Pasadena, California 91125*
[22] *University of California, San Diego, La Jolla, California 92093*

(July 3, 1995)

Abstract

Using data collected with the CLEO II detector, we have observed the isospin-violating decay $D_s^{*+} \to D_s^+ \pi^0$. The decay rate for this mode, relative to the dominant radiative decay, is found to be $\Gamma(D_s^{*+} \to D_s^+ \pi^0)/\Gamma(D_s^{*+} \to D_s^+ \gamma) = 0.062^{+0.020}_{-0.018} \pm 0.022$. This is within the range of theoretical predictions.

PACS numbers: 13.25.Fc, 14.40.Lb

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*Permanent address: University of Hawaii at Manoa

Since the discovery of the charmed strange vector meson D_s^{*+}, only the radiative decay mode $D_s^{*+} \to D_s^+\gamma$ has been observed [1,2]. Due to the small mass difference between the D_s^{*+} and the D_s^+, the only kinematically allowed strong decay is $D_s^{*+} \to D_s^+\pi^0$. However, this decay violates strong isospin conservation, since the initial state has $I = 0$ and the final state has $I = 1$. But strong isospin is not an exact symmetry, so this decay is not completely forbidden. For example, the decay $\psi' \to J/\psi\ \pi^0$, which has been observed by several experiments [1], violates isospin conservation.

Recently, Cho and Wise made a prediction for the rate of this strong D_s^{*+} decay [3]. Using Chiral Perturbation Theory, they describe the decay as an isospin-conserving decay involving a virtual η, $D_s^{*+} \to D_s^+\eta$; the η couples through its $s\overline{s}$ component, so this decay is not OZI-supressed. This is followed by the η mixing into a π^0. This isospin-violating mixing vanishes in the limit of equal up and down quark masses. The decay amplitude is proportional to the light quark masses in the combination $(m_d - m_u)/[m_s - (m_d + m_u)/2]$, which is ~ 0.02–0.03 [1]. They also conclude that the radiative decay rate is further suppressed (relative to $D^{*0} \to D^0\gamma$) because of the partial cancellation of the magnetic moments of the charm and strange quarks. The same type of cancellation accounts for the small radiative decay rate of the D^{*+} [4].

Thus Cho and Wise relate the rate for $D_s^{*+} \to D_s^+\gamma$ to that for $D^{*+} \to D^+\gamma$ in order to estimate the ratio of partial widths [3]: $R_0 \equiv \Gamma(D_s^{*+} \to D_s^+\pi^0)/\Gamma(D_s^{*+} \to D_s^+\gamma) = \sim 0.01{-}0.10$. Unfortunately, there are corrections to the prediction which might be negligible, but are uncalculable. There is also an electromagnetic amplitude for the decay to $D_s^+\pi^0$, but it is expected to be smaller than the strong amplitude by a factor of order α/π.

We have searched for $D_s^{*+} \to D_s^+\pi^0$ using the decay chain $D_s^+ \to \phi\pi^+$, $\phi \to K^+K^-$. At the same time, we measure the rate of the radiative decay, to normalize the hadronic decay rate. Since the same charged-track selection criteria are used for both decay modes, only the relative efficiencies for finding a single photon or reconstructing a π^0 are needed.

The data used in this analysis were collected with the CLEO II detector at CESR. The detector consists of a charged particle tracking system surrounded by time-of-flight (TOF) scintillation counters. These are in turn surrounded by an electromagnetic calorimeter, which consists of 7800 thallium-doped CsI crystals. The inner detector is immersed in a 1.5 T solenoidal magnetic field generated by a superconducting coil. Finally, the magnet coil is surrounded by iron flux return and muon counters. Charged particle identification is provided by specific ionization measurements in the main drift chamber and by TOF measurements. A detailed description of the detector can be found elsewhere [5].

The data were taken at center-of-mass energies equal to the masses of the $\Upsilon(3S)$ and $\Upsilon(4S)$, and in the continuum above and below the $\Upsilon(4S)$. The total integrated luminosity is 3.75 fb^{-1}. Events were required to have a minimum of three charged tracks, and energy in the calorimeter equal to at least 15% of the center-of-mass energy.

Charged tracks were initially required to pass a loose particle identification consistency. We required that the specific ionization measurement be within three standard deviations of that expected for the hypothesis in question, either kaon or pion.

Only energy clusters in the barrel calorimeter with $|\cos\theta| \leq 0.71$ (where θ is the polar angle with respect to the beamline) which were not matched to tracks were used as photons. They were required to have a minimum of energy of 30 MeV, and to pass a lateral shape cut to help eliminate energy from hadronic interactions. Single photons used to reconstruct

the radiative decay were required to have energy greather than 50 MeV. Pairs of photons were used to reconstruct π^0's. The invariant mass of the two photons was required to be within 2.5 standard deviations of the π^0 mass; this cut takes into account the asymmetric π^0 lineshape and the small momentum dependence of the mass resolution. The π^0 candidates were kinematically fit to the π^0 mass to improve momentum resolution. The decay angle, θ_γ of the π^0 is defined as the angle between the direction of one of the photons in the π^0's rest-frame and the π^0's direction in the lab-frame. We required $|\cos\theta_\gamma| \leq 0.75$, since the background peaks near $|\cos\theta_\gamma| = 1$, while the signal is flat. The π^0's were also required to have a minimum momentum of 250 MeV/c.

We began the reconstruction by taking pairs of oppositely charged tracks, consistent with being kaons, and calculating the invariant mass. Those pairs whose invariant mass was within ± 9 MeV/c^2 of the ϕ mass [1] were accepted as ϕ candidates. Then each remaining charged track, consistent with being a pion, was combined with the ϕ to try to make a D_s^+. The D_s^+ candidates were required to pass two angle cuts. To reduce background from slow pions, we required $\cos\theta_\pi \geq -0.9$, where θ_π is the decay angle of the π^+ (the angle between the pion's direction in the D_s^+ rest frame, and the D_s^+'s direction in the lab frame). The signal distribution is flat, while the background peaks near $\cos\theta_\pi = -1$. Second, because the ϕ must be polarized in the helicity-zero state, the kaons must have a helicity angle distribution proportional to $\cos^2\alpha$, where α is the angle between the kaon and the D_s^+, both measured in the ϕ rest-frame. We required $|\cos\alpha| \geq 0.35$.

Next, we imposed a more restrictive particle identification cut on the three-track combination. A particle ID χ^2 was calculated using the specific ionization measurements for each of the three tracks, plus the TOF measurements for each track which had good TOF information. We required that the χ^2 probability, for the appropriate number of degrees of freedom, be at least 0.1. Finally, D_s^+ candidates had to have a mass within two standard deviations (16 MeV/c^2) of the D_s^+ mass [1].

To reconstruct the radiative decay mode, the D_s^+ candidates were combined with each photon in the event which had an energy of at least 50 MeV. The mass difference, $\Delta M_\gamma \equiv M(D_s^+\gamma) - M(D_s^+)$ was calculated [6]. The scaled momentum, x, of each D_s^{*+} candidate was calculated as $x = p/p_M$, where $p_M^2 = E_b^2 - M_{D_s^{*+}}^2$, and E_b is the beam energy. After requiring $x \geq 0.6$, we histogram ΔM_γ. The resulting distribution was fit using a modified Gaussian with an enhanced low-energy tail for the signal and a third-order polynomial for the background. We find 944 ± 57 signal events.

Next, each D_s^+ candidate was combined with each π^0 with momentum of at least 250 MeV/c. The mass difference $\Delta M_0 \equiv M(D_s^+\pi^0) - M(D_s^+)$ was calculated. An x cut of $x \geq 0.6$ was again applied to each D_s^{*+} candidate. The remaining D_s^{*+} candidates are shown in Fig. 1. The plot was fit using a Gaussian for the signal and a square-root function that goes to 0 at threshold to represent the background. The r.m.s. width of the Gaussian was fixed at $\sigma = 1.2$ MeV/c^2, as determined by the Monte Carlo. The mean was fixed at 144.22 MeV/c^2, as previously measured by CLEO II [7]. We find $14.7^{+4.6}_{-4.0}$ signal events (statistical errors only).

We also studied the D_s^+ and π^0 sidebands. We used $\phi\pi^+$ combinations with masses between 1904 and 1936 MeV/c^2, and between 2004 and 2036 MeV/c^2, and combined them with π^0's. We also selected $\gamma\gamma$ combinations that were between 2.75 and 7.75 standard deviations away from the π^0 mass; this corresponds approximately to an invariant mass

between 88 and 118 MeV/c^2, or between 145 and 165 MeV/c^2; these were combined with our D_s^+ candidates. These two sets of sideband combinations produce the ΔM_0 distribution shown as a dashed histogram in Fig. 1. The entries in this histogram have been scaled by a factor of 0.5, to account for the fact that the sidebands are twice as wide as the signal band. If we fit this sideband histogram the same way as the signal band events, the area of the Gaussian is $-1.0^{+3.1}_{-2.4}$ events, consistent with zero.

As a check, we have also analyzed events in the Cabibbo-suppressd decay chain $D^{*+} \to D^+\pi^0$, $D^+ \to \phi\pi^+$. We used the same cuts as before, but required the $\phi\pi^+$ invariant mass to lie in the D^+ signal region from 1853.3 to 1885.3 MeV/c^2. Using a Gaussian with mean fixed at 140.64 MeV/c^2, as measured by CLEO II [8], we find $28.6^{+6.0}_{-5.4}$ signal events (statistical errors only). Using our measured luminosity, and published cross sections [9] and branching ratios [1], we expect 23.7 ± 4.2 events.

In order to confirm that this signal is from $D_s^{*+} \to D_s^+\pi^0$ rather than $D_s^{*+} \to D_s^+\gamma\gamma$ we have relaxed the cut on the two photon invariant mass used in the π^0 selection. We then cut on ΔM_0, and study the $\gamma\gamma$ invariant mass distribution. Fitting this distribution yields a π^0 signal of $16.1^{+4.6}_{-4.0}$ events, consistent with our previous result. Similarly, when we cut on ΔM_0 and fit the $\phi\pi^+$ invariant mass distribution we find $13.9^{+4.8}_{-4.1}$ signal events.

The background appears to be dominated by random combinations, rather than feed-through from some other physics channel. For example, two other conceivable sources of background, real $D_s^{*+} \to D_s^+\gamma$ events with an extra soft photon faking a π^0, and misidentified $D^{*+} \to D^+\pi^0$ events are both neglible.

We have generated $D_s^{*+} \to D_s^+\gamma$ Monte Carlo events and analyzed them with the reconstruction program. The Monte Carlo sample is 50% larger than our actual data sample. Only 3 events with 135 MeV/$c^2 \leq \Delta M_0 <$ 160 MeV/c^2 are found; they are outside the signal region 141 MeV/$c^2 \leq \Delta M_0 <$ 147 MeV/c^2.

Similarly, background from misidentifed D^{*+} decays is not a problem. The particular decay chain considered is: $D^{*+} \to D^+\pi^0$, $D^+ \to K^-\pi^+\pi^+$, where one of the pions is misidentified as a kaon, so that the three charged tracks reconstruct near the D_s^+ mass. The reason these events are not a problem is that it is almost impossible for such a fake kaon to make a ϕ, and then for the fake ϕ plus the real pion to make a D_s^+. This was tested by taking each D_s^+ candidate and changing the particle identification of the kaon, which had the same sign as the pion, from kaon to pion. We recalculated the invariant mass of the the three tracks and found that none of the calculated masses were greater than 1845 MeV/c^2. We also generated a large number of Monte Carlo events to study this background and confirmed that they could not produce such a peak. Finally, by studying the data, we found that even if such a background existed, these events would have a broader peak at ΔM_0 near 140.64 MeV/c^2, rather than 144.22 MeV/c^2. Other similar decays of charmed mesons, which are partially reconstructed, and include misidentified particles, can contribute to the signal histogram. Monte Carlo studies showed, however, that such events do not form a peak.

We have evaluated the statistical significance of $D_s^{*+} \to D_s^+\pi^0$ events in two ways. First, we refit the signal histogram (Fig. 1), constraining the area of the Gaussian to zero. The change in likelihood from the original fit is equivalent to 5.0 standard deviations.

Secondly, we counted the number of events with 142 MeV/$c^2 \leq \Delta M_0 <$ 146 MeV/c^2 in both the signal histogram and the sideband histogram. This yields 16 signal events and 5 sideband events. Taking into account that the sideband width is twice the signal band

width, the binomial probability of getting 16 (or more) signal events out of 21 total events is 7.3×10^{-5}, equivalent to 3.9 standard deviations. Thus we consider the observation to have 3.9 standard deviation significance.

Using the CLEO Monte Carlo program, we found the ratio of efficiencies for reconstructing the hadronic and radiative events. This ratio is 0.25 ± 0.03. Using this ratio and the numbers of events reconstructed, we find that the ratio of partial widths is $R_0 = 0.062^{+0.020}_{-0.018}$, where these statistical errors are dominated by the error on the number of $D_s^+\pi^0$ events. This is within the range predicted by Cho and Wise [3].

We estimate that the systematic error on R_0 is 35%. This is dominated by variations in R_0 when we vary our cuts on the π^0 and/or photons. Thus our measurement of the ratio of partial widths is

$$R_0 = \frac{\Gamma(D_s^{*+} \to D_s^+\pi^0)}{\Gamma(D_s^{*+} \to D_s^+\gamma)} = 0.062^{+0.020}_{-0.018} \pm 0.22 \text{ [10]}.$$

If we assume these two branching fractions sum to one, the individual branching fractions are:

$$\mathcal{B}(D_s^{*+} \to D_s^+\pi^0) = 0.058^{+0.018}_{-0.016} \pm 0.020 \quad (1)$$

$$\mathcal{B}(D_s^{*+} \to D_s^+\gamma) = 0.942^{+0.016}_{-0.018} \pm 0.020. \quad (2)$$

The observation of this decay mode implies that the D_s^{*+} must have natural spin-parity (0^+, 1^-, $2^+ \ldots$), since conservation of parity and angular momentum forbid the decay of a particle with unnatural spin-parity to two pseudoscalars. The radiative decay rules out $0^\pm$; the most likely spin-parity is $J^P = 1^-$, the same as the D^{*0} and D^{*+} [1].

Using the $D_s^{*+} \to D_s^+\pi^0$ events, we can make a new measurement of the mass difference $M_{D_s^{*+}} - M_{D_s^+}$, and set a new upper limit on the width of the D_s^{*+}. We refit the ΔM_0 distribution, allowing the mean of the signal Gaussian to float. With the width of the Gaussian fixed, the mean is fit to $\Delta M_0 = 143.76 \pm 0.39$ MeV/c^2 (statistical error only). Fitting the $D^{*+} \to D^+\pi^0$, $D^+ \to \phi\pi^+$ events mentioned above, we find a $M_{D^{*+}} - M_{D^+}$ of 140.31 ± 0.26 MeV/c^2, in good agreement with the previous CLEO II measurement of 140.64 ± 0.10 MeV/c^2 [8]. We include the 0.33 MeV/c^2 difference in the systematic error of the ΔM_0 measurement. It has previously been estimated that the uncertainty in the crystal energy calibration introduces a systematic error of 0.04 MeV/c^2 in this type of measurement [8]. Changing the cuts used to select the events introduces variations of 0.22 MeV/c^2; other effects, such as varying the background function used for the fit, produce much smaller variations. Thus we estimate the systematic error to be 0.40 MeV/c^2. Therefore we measure $M_{D_s^{*+}} - M_{D_s^+} = 143.76 \pm 0.39 \pm 0.40$ MeV/c^2, in excellent agreement with the previous CLEO II value $144.22 \pm 0.47 \pm 0.37$ MeV/c^2 from the radiative mode [7]. The two measurements are statistically independent, and have almost completely independent systematic errors. Averaging the two, we find $M_{D_s^{*+}} - M_{D_s^+} = 143.97 \pm 0.41$ MeV/c^2. This may be compared with the Particle Data Group's fit value of 141.6 ± 1.8 MeV/c^2, or their average value of 142.4 ± 1.7 MeV/c^2 [1]; the PDG's values do not include the earlier CLEO II measurement.

The width of the signal is consistent with being entirely due to detector resolution. The Monte Carlo calculation predicts a value of $\sigma = 1.19 \pm 0.07$ MeV/c^2 for the signal Gaussian (statistical error only). The measured r.m.s. width of the signal Gaussian is $\sigma =$

$1.06^{+0.41}_{-0.28}$ MeV/c^2. Assuming a 10% systematic error on the Monte Carlo prediction for σ, and fitting the signal with a p-wave Breit-Wigner convoluted with a Gaussian, we can set a 90% confidence level upper limit $\Gamma(D_s^{*+}) < 1.9$ MeV/c^2. This can be compared with the best existing limit, from ARGUS [11], $\Gamma(D_s^{*+}) < 4.5$ MeV/c^2.

In conclusion, we have detected the isospin-violating decay $D_s^{*+} \to D_s^+\pi^0$, and find the ratio of partial widths, $R_0 = 0.062^{+0.20}_{-0.18}\pm 0.022$, in good agreement with a recent prediction [3]. If that calculation is correct, it predicts (with a two-fold ambiguity) a branching fraction for $D^{*+} \to D^+\gamma$ of 0.8–1.0%, or of $\sim 0.1\%$, based on this value of R_0. Assuming that any other decay modes of the D_s^{*+} are negligible compared to $D_s^+\gamma$ and $D_s^+\pi^0$, we find the branching fractions: $\mathcal{B}(D_s^{*+} \to D_s^+\gamma) = 0.942^{+0.016}_{-0.018} \pm 0.020$ and $\mathcal{B}(D_s^{*+} \to D_s^+\pi^0) = 0.058^{+0.018}_{-0.016} \pm 0.020$. In addition, we find $M(D_s^{*+}) - M(D_s^+) = 143.76 \pm 0.39 \pm 0.40$ MeV/c^2, and we obtain an improved upper limit $\Gamma(D_s^{*+}) < 1.9$ MeV/c^2 (90% C.L.). The observation of this decay mode implies that the D_s^{*+} has natural spin-parity, most likely 1^-.

One of us (J.B.) would like to thank Peter Cho and Mark Wise for stimulating discussions. We gratefully acknowledge the effort of the CESR staff in providing us with excellent luminosity and running conditions. This work was supported by the National Science Foundation, the U.S. Department of Energy, the Heisenberg Foundation, the Alexander von Humboldt Stiftung, the Natural Sciences and Engineering Research Council of Canada, and the A.P. Sloan Foundation.

REFERENCES

[1] Particle Data Group, L. Montanet *et al.*, Phys. Rev. **D 50**, 1173 (1994).
[2] Throughout this paper, reference to a particular charge state implies inclusion of the charge-conjugate state as well.
[3] P. Cho and M. B. Wise, Phys. Rev. **D 49**, 6228 (1994).
[4] CLEO Collaboration, F. Butler *et al.*, Phys. Rev. Lett. **69**, 2041 (1992).
[5] CLEO Collaboration, Y. Kubota *et al.*, Nucl. Instrum. & Methods **A320**, 66, (1992).
[6] $M(D_s^+\gamma)$, $M(D_s^+)$ refer to the invariant mass of the tracks in the $D_s^+\gamma$ and D_s^+ candidates, respectively. Similar notation will be used for the invariant masses of other track combinations.
[7] CLEO Collaboration, D.N. Brown *et al.*, Phys. Rev. **D 50**, 1884 (1994).
[8] CLEO Collaboration, D. Bortoletto *et al.*, Phys. Rev. Lett. **69**, 2046 (1992).
[9] CLEO Collaboration, D. Bortoletto *et al.*, Phys. Rev. Lett. **37**, 1719 (1988); ARGUS Collaboration, H. Albrecht *et al.*, Z. Phys. **C 52**, 353 (1991).
[10] Throughout this paper, when two errors are listed, the first is statistical and the second systematic.
[11] ARGUS Collaboration, H. Albrecht *et al.*, Phys. Lett. **B 207**, 349 (1988).

FIGURES

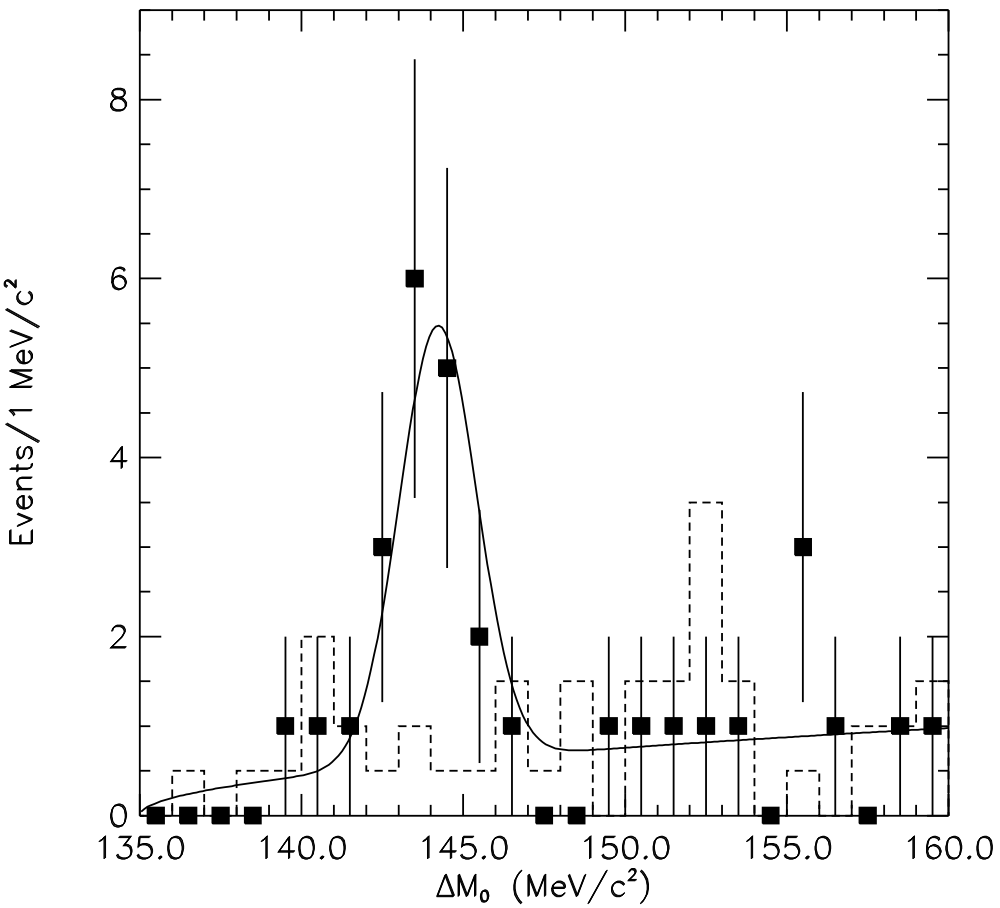

FIG. 1. The solid squares are the signal for the isospin-violating decay $D_s^{*+} \to D_s^+\pi^0$. The solid line indicates the fit to the data, using a Gaussian of fixed mean and width for the signal and a square-root threshold function for the background. The dashed line shows the mass difference histogram for $(\phi\pi^+)\pi^0$ events, where the $\phi\pi^+$ invariant mass falls in the D_s^+ mass sidebands, plus $D_s^+\gamma\gamma$ events, where the $\gamma\gamma$ invariant mass falls in the π^0 sidebands. The number of events per bin in the sideband histogram has been scaled by 0.5, to account for the fact that the sidebands are twice as wide as the signal band.