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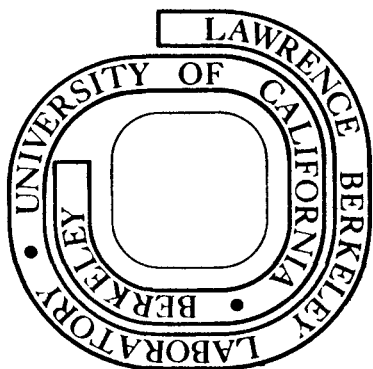
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Mahiko Suzuki

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Is the Axial Vector Charmed Meson Found ?

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It is argued that the charmed meson of $J^P = 1^+$ is produced copiously at the center-of-mass energy 4.028 GeV in electron-positron annihilation.

Goldhaber et al. have reported evidences for charmed mesons in a recent Letter,¹ in which they have shown among others the recoil mass spectrum against D^0 (\bar{D}^0). De Rujula et al.² have subsequently attributed the higher peak in the recoil mass spectrum to the kinematic reflection of the $D^{0*}(1^-) \bar{D}^{0*}(1^-)$ production. With more accurate values^{1,3} for the masses involved and with the actual beam energy. ($\sqrt{s} = 4.028 \pm 0.005$ GeV), however, the ratio of the $D^0(0^-) \bar{D}^{0*}(1^-) + \bar{D}^0(0^-) D^{0*}(1^-)$ and $D^{0*}(1^-) \bar{D}^{0*}(1^-)$ production cross sections turns out to be

$$\sigma(D^{0*}\bar{D}^{0*}) / \{\sigma(D^0\bar{D}^{0*}) + \sigma(\bar{D}^0D^{0*})\} \approx 0.052 \quad (1)$$

aside from possible form factor effects, provided that the quark model

based on statistical spin weight be valid.² The small number in (1) is due to the vanishingly small Q value available for the $D^{0*}\bar{D}^{0*}$ channel. To explain the height of the higher recoil mass peak, this has to be close to the order of unity.

An alternative interpretation, probably more faithful to the experiment, is that the higher recoil mass peak is due to the production of $D^0(0^-) \bar{D}^{0**}(1^+)$ and its charge-conjugate state. In this case the mass is estimated from the momentum spectrum of D^0 (\bar{D}^0) to be 2.147 GeV. Since the production takes place in an s-wave, the small Q value suppresses less severely the $(0^-, 1^+)$ production than the $(1^-, 1^-)$ production. This value of the 1^+ charmed meson mass is considerably smaller than 2.33 GeV of a quark mass spectroscopy⁴ and 2.5 GeV of a linearly rising potential model.⁵ It does not fit in linear mass formulas, but it satisfies approximately the quadratic mass formulas,

$$\begin{aligned} m^2(D^{0**}) - m^2(D^{0*}) &\approx 0.59 \text{ GeV}^2, \\ m^2(A_1) - m^2(\rho) &\approx 0.62 \text{ GeV}^2, \\ m^2(K_A) - m^2(K^*) &\approx 0.74 \text{ GeV}^2. \end{aligned} \quad (2)$$

Treating the production at $\sqrt{s} = 4.028$ GeV as $\gamma \rightarrow \psi_{4.03} \rightarrow$ charmed mesons, one can get some idea of the relative magnitude of the $D^0(0^-) \bar{D}^{0**}(1^+)$ and $D^0(0^-) \bar{D}^{0*}(1^-)$ production cross sections from the $A_1\rho\pi$ and $\omega\rho\pi$ couplings as follows: Let us assume that the $\psi_{4.03}$ state, as a member of an excited hexadecimet vector multiplet of SU(4), couples with the $0^-, 1^-,$ and 1^+ mesons as the $\psi_{3.1}$ state does, namely,

$$g(\psi_{4.03}DD^*)/g(\psi_{4.03}D\bar{D}^{0**}) \approx g(\psi_{3.1}D\bar{D}^*)/g(\psi_{3.1}D\bar{D}^{0**}). \quad (3)$$

References

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1. G. Goldhaber et al., Phys. Rev. Letters 27, 255 (1976).
2. A. De Rujula, H. Georgi, and S. L. Glashow, Phys. Rev. Letters 27, 398 (1976). See also Reference 5.
3. G. Goldhaber, a talk at SLAC Summer Conference on Particle Physics, August, 1976. $m(D^0) = 1866.5$ MeV and $m(D^{0*}) - m(D^0) = 138.9$ MeV.
4. A. De Rujula, H. Georgi, and S. L. Glashow, Phys. Rev. D12, 147 (1975).
5. K. Lane and E. Eichten, Phys. Rev. Letters 27, 477 (1976).
6. The D^{0**} meson is assumed here to be a 3P_1 state.
7. N. Cabibbo and R. Gatto, Phys. Rev. 124, 1577 (1961).
8. Some data are available at $\sqrt{s} = 4.1$ GeV, but they are not sufficient statistically to plot the recoil mass spectrum.

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