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TOP QUARK MESONS AND THEIR PHOTO PRODUCTION

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The photo-production of 'Truth' quark is re-examined within Q.C.D. and the possibility of the experimental measurement of the cross section is briefly discussed.

Keywords : Top Monium; Photo Production; VMD.

INTRODUCTION

THE interest in searching for mesons with top quark is increasing. The photo production of heavy quark flavours has been discussed within QCD by several authors. (Jones & Wyld, 1978; and Babcock *et al.*, 1978). Here, in this paper we will discuss the probable mechanism of the process $\bar{q}q \rightarrow t\bar{t}$ where $\bar{q}$ comes from the hadronized Photon.

Within QCD, a photon has two components: a point like component and a hadronic component. In low momentum transfer processes, the incoming photon couples directly to a bound state of quarks and gluons. This is a non-perturbative phenomenon and can be described approximately by the vector mesons dominance (VMD).

It is known that in the conventional model [SU (3) particles] the relations between strong production cross section and photo production cross section that are based on vector meson dominance (VMD) assumptions for the electro-magnetic currents of the hadrons, independent of the reaction mechanism, are in good agreement with the experiment. (Dany *et al.*, 1968; Gellman & Zaoberiasen, 1961; and Kvoll *et al.*, 1967).

Motivated by this idea of VMD, several authors have discussed the diffractive production of a vector Boson. Carrying a new quark member of heavy quarkonia such as discussed in neutrino-anti-neutrino scattering. They are based on the theoretical possibility that a new vector boson F^* particle might exist which couples with charged week interaction current J_μ in the same way as the ρ^o, ω, ϕ and ψ do to the e.m. current. We have presumed this possibility following the suggestion of Ellis and Gailard (1977). But in the present context, as we are dealing with heavier quarkonia t and whose spectroscopy is still to be identified experimentally, our conclusions and views are different with those of the above mentioned papers. However, we believe that VMD assumptions can be exploited in the above model.

PHOTO PRODUCTION OF HADRONS WITH TOP QUARK AND DIFFRACTIVE PRODUCTION

Although the mass of truth quark m_t is large, we assume as in bottom model that $\bar{q}q \leftarrow t\bar{t}$ mechanism is still proportional to $\alpha\alpha_s^2$ instead of $\alpha\alpha_s$ like $\gamma - g$ amalgamation.

The contribution of $\gamma - g$ amalgamation is (cf. Jones & Wyld, 1978; and Babcock *et al.*, 1978)

$$\sigma(\gamma p \rightarrow t\bar{t}\, x) = \int_{4m^2/s}^{1} dx\; \hat{\sigma}(xs)\, G(xQ^2) \qquad \ldots(1)$$

where

$$\hat{\sigma}(xs) = \frac{\pi\alpha\alpha_s^2 e^2}{xs}\left\{(3 - \beta^4)\log\frac{1+\beta}{1-\beta} - 2\beta(2 - \beta^2)\right\}$$

$$\beta = (1 - 4\, m_t^2/xs)^{1/2}\quad e_t = 2/3$$

and $G(xQ^2)$ is the gluon distribution inside the proton. S is the total energy squared in the γp. *cm* system. With the constraint

$$\int_0^1 xG(xQ^2)\, dx \sim 0.2, \qquad \text{we take}$$

$$G(xQ^2) \sim \frac{n+1}{5}\,\frac{(1-x)^n}{x}$$

According to QCD, the values of n should depend on the momentum transfer Q^2. For $t\,\bar{t}$ production, it is reasonable to take $Q^2 \sim 4m_t^2 \sim 900$ GeV^2 for Buras and Gaemers (1978) parametrization.

The total cross section of the *qq-tt* now becomes

$$\sigma(\gamma p \rightarrow t\bar{t}x) \sim \iint_{xys \geqslant 4m_t^2} dx\, dy\hat{\sigma}(xys) \sum_q \{q^{-\gamma}(yQ^2)\, q^p(xQ^2)$$

$$+ q^{\gamma}(yQ^2)\, q^{-p}(xQ^2)\} \qquad \ldots(2)$$

where $$\hat{\sigma}(xys) = \frac{0.930\, \alpha_s^2}{(xys)^3}\,[xys\,[xys - 4m_t^2)]^{1/2}\;[xys\; 2\, m_t^2)$$

$$\sum_q (q^{-\gamma}(y, Q^2)\, q^p(x, Q^2) + q^{\gamma}(y, Q^2)\, q^{-p}(x, Q^2)]$$

$$= \frac{1}{xy}\, yq^{\gamma}_{2/3}(y, Q^2)\,\{xU^p_{\gamma}(x, Q^2) + 0.25\, xd^p_{\gamma}(x, Q^3)$$

$$+ \cdot 5\, xs^{-p}(x, Q^2)\}$$

Where $q^{\gamma}_{2/3}(yQ^2)$ is the 2/3 e charged quark distribution function of the Photon and U^p_{γ}, d^p_{γ}, s^p are valence up, down and sea quark distribution functions in the proton respectively. We use

$$\alpha_s(4m_t^2) \sim 0.2 \quad \alpha_s(Q^2) \sim \frac{0.2}{\left[1 + .114 \log \frac{Q^2}{(4m_t^2)}\right]}$$

The ratio of the cross-section of top mesons and bottomed mesons is given by (Babcock *et al.*, 1978). We have

$$\frac{\sigma(\gamma p \to t\bar{t}x)}{\sigma(\gamma p \to B\bar{B}\,x)} \sim \frac{M_T}{M_H} \frac{\Gamma_t \to e^+e^-}{\Gamma_b \to e^+e^-} \frac{\sigma(HN)}{\sigma(TN)} \qquad \ldots(3)$$

We assume (Ellis & Gaillard, 1977)

$$\frac{\sigma(HN)}{\sigma(TN)} \sim \frac{M_T^2}{M_H^2} \qquad \ldots(4)$$

Then

$$\frac{\sigma(\gamma p \to t\bar{t}x)}{\sigma(\gamma p \to B\bar{B}x)} \sim 11 \times 10^{-2}$$

Using

$$\sigma(\gamma p \to B\bar{B}x) \sim 10\ nb$$

We predict that

$$\sigma(\gamma p \to t\bar{t}x) \sim 1.1\ nb$$

Conclusions

In order to observe $t\bar{t}$ state or top mesons, we expect the total cross-section of the order of 1.1 nb which is nearly the experienced upper limit when searching for $t\bar{t}$ is 1 event/pb. This means we can have 2000 $t\bar{t}$ events or 4000 events of t and $\bar{t}$. In the $c\bar{c}$ state, the total cross section is much greater than that of $b\bar{b}$ and we are getting for $t\bar{t}$ state a value for which is yet smaller than that of mesons containing a beauty quark. Hence justified is our prediction.

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