

ISOSPIN AND G-PARITY OF THE $\psi''(3770)$

BY P. MUKHOPADHYAY

Jadavpur University, Calcutta*

(Received August 17, 1978)

It is suggested in this note that the $\psi''(3770)$ must have $I^G = 0^-$.

It may be recalled that the most recently discovered [1] ψ -particle, namely, the $\psi''(3770)$ has been found to undergo the strong decay dominantly into $D\bar{D}$ which is the only hadronic mode so far identified [1] for the particle concerned. This fact precludes, at least for the time being, the determination of the G -parity of the particle under considerations arising out of the non-availability of the pure pionic mode(s) or the mode(s) involving particles having well defined G -parities. It is well known that the G -parity of the D -meson, being an iso-spinor [2], is undefined. The knowledge of the G -parity of the $\psi''(3770)$ can, however, be obtained through the well known relation [1] $G = C_n(-1)^I$ if the isospin I of the particle concerned can be uniquely specified. Unfortunately, the isospin invariance alone in the strong decay $\psi''(3770) \rightarrow D\bar{D}$ is not sufficient for finding out the isospin state of the $D\bar{D}$ system and as such the same for the $\psi''(3770)$. Obviously, the $D\bar{D}$ system can appear either in the $I = 1$ or $I = 0$ state which in turn implies that the $\psi''(3770)$ can have $I = 1$ or $I = 0$. It may be noted that the unique specification of the isospin state of the $D\bar{D}$ system necessitates an additional physical constraint apart from the isospin invariance in the strong decay $\psi''(3770) \rightarrow D\bar{D}$. There is hardly any need of emphasizing that the additional physical constraint for finding out the isospin state of the $D\bar{D}$ system cannot be imposed in the form of the symmetry requirement on the overall wavefunction (comprised of the wavefunctions in the isospace and actual space) of the system concerned. Stated more clearly, one cannot demand that the overall wavefunction of the $D\bar{D}$ system should be symmetric as the D -mesons are iso-fermions. The difficulty of uniquely specifying the isospin of the $\psi''(3770)$ can be bypassed with the help of the following selection rule: "An iso-vector meson *cannot* suffer a strong decay *dominantly* into two bosons which are iso-spinors of identical actual spins (like $K\bar{K}$ or $D\bar{D}$)". A look into the decay modes of the *iso-vector* mesons [1] will reveal the fact that the selection rule is valid for all the iso-vector mesons so far known *without a single exception*.

* Address: Department of Physics, Jadavpur University, Calcutta 700032, India.

It is interesting to examine the decay $\psi''(3770) \rightarrow D\bar{D}$ in the light of the selection rule given above. Since the $D\bar{D}$ system can occur either in the $I = 1$ or in the $I = 0$ state, therefore, the $\psi''(3770)$ can be an iso-vector or an iso-scalar. If possible, let us assume that the $\psi''(3770)$ is an iso-vector. This assumption is, however, in serious contradiction with the above selection rule since the $\psi''(3770)$, assumed to be an iso-vector, is found to suffer strong decay *dominantly* into $D\bar{D}$ which are iso-spinors of identical actual spins. Obviously, then, our assumption that the $\psi''(3770)$ is an iso-vector is not true. As out of the two possible values ($I = 1$ and $I = 0$) of the isospin of the $\psi''(3770)$, the value $I = 1$ is ruled out by the selection rule given above, therefore, the particle concerned must have $I = 0$. The well known relation [1] $G = C_n(-1)^I$ indicates that G -parity of the $\psi''(3770)$ must be odd since for it $I = 0$ and C_n is odd [1]. We conclude, therefore, that the $\psi''(3770)$ must have $I^G = 0^-$.

REFERENCES

- [1] Particle Data Group, *Review of Particle Properties*, 1978.
- [2] M. K. Gaillard, B. W. Lee, J. L. Rosner, *Rev. Mod. Phys.* **47**, 277 (1975).