The 20-plet of vector mesons

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It is assumed that the two resonances in the e^+e^- channel from the mass interval 3.68–4.42 GeV can be identified with two mesons from the $SU(4)$ 20-plet. The ratios of the widths of the decay of these mesons to e^+e^- and the quantum numbers of the members of the 20-plet are obtained.

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It is known that the properties of the recently discovered heavy mesons such as J/ψ, ψ', and κ are well described by the quark model if a fourth charmed quark is used.[1] In this model ψ' is usually treated as a radial excitation of ψ, which likewise does not contradict the existing data.[1,2]

However, a complex structure of peaks, including the ψ' meson, has been observed in the mass interval $M \sim 3.68$–4.42 GeV, and some of these peaks can be subsequent radial excitations of the ψ meson, or/and bound states of charmed mesons.[2,3]

In this article we set in correspondence two peaks from this region with the mesons C_0^0 and $C_1^0(I_3=0)$ from the 20-dimensional $SU(4)$ multiplet. An important requirement for an unambiguous identification of C_0^0 and C_1^0 with the obtained resonances is that the isospins of C_0^0 and C_1^0 differ by unity. The critical fact for the experimental confirmation of the existence of the 20-dimensional $SU(4)$ multiplet of mesons would be the observation of charmed mesons with unity isospin. Such mesons, called G-mesons, cannot be obtained within the framework of the ordinary $SU(4)$ quark model.

We consider in greater detail the properties of the mesons belonging to the 20-dimensional multiplet. It is easy to determine the quantum numbers of these mesons. We write them out and omit in some cases the antiparticles. C, S, I, and Q denote respectively the values of the charm, strangeness, isospin, and charge.

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TABLE I. The C^0, C_1^0, C_0^0 and $\bar{C}^0$ mesons form an $SU(3)$ octet.

	C	S	I	Q
G mesons	1	1	1	(2,1,0)
C^+ mesons	1	0	1/2	(1,0)
C_0^+ meson	1	−1	0	0
C^0 mesons	0	1	1/2	(1,0)
C_1^0 mesons	0	0	1	(1,0,−1)
C_0^0 meson	0	0	0	0

In contrast to the main 15-plet, the masses of the mesons belonging to the 20-plet cannot be determined uniquely. However, one should expect the splitting with respect to the masses of the C mesons from the $SU(3)$ octet to be much less than the splitting obtained in the model with radial excitations. The maximum mass difference for the mesons from the 20-plet is most likely not larger than 1 GeV.

We calculate now the ratio of the widths $\Gamma(C_0^0 \to e^+e^-)$ and $\Gamma(C_1^0(I_3=0) \to e^+e^-)$, using the remark made by Yennie[4] that these ratios are independent of mass for the family of the known vector mesons. Recognizing that C_0^0 and C_1^0 mesons belong to the $SU(3)$ octet, we obtain $\Gamma(C_1^0(I_3=0) \to e^+e^-) : \Gamma(C_0^0 \to e^+e^-) \approx 3 : 1$.

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