Eur. Phys. J. C (2017) 77:545
DOI 10.1140/epjc/s10052-017-5127-8

THE EUROPEAN PHYSICAL JOURNAL C

Erratum

Erratum to: Spin-1 diquark contributing to the formation of tetraquarks in light mesons

Hungchong Kim[1,a], **Myung-Ki Cheoun**[2], **K. S. Kim**[3]

[1] Research Institute of Basic Science, Korea Aerospace University, Goyang 412-791, Korea
[2] Department of Physics, Soongsil University, Seoul 156-743, Korea
[3] School of Liberal Arts and Science, Korea Aerospace University, Goyang 412-791, Korea

Received: 27 July 2017 / Accepted: 1 August 2017 / Published online: 14 August 2017

Erratum to: Eur. Phys. J. C (2017) 77:173
DOI 10.1140/epjc/s10052-017-4736-6

In the paper above, we have proposed a tetraquark picture with the mixing scheme for the $I_z = 1$ members of the isovector ($I = 1$) resonances, $a_0^+(980)$, $a_0^+(1450)$. In particular, their mass splittings fit relatively well with the hyperfine mass splittings if they are viewed as mixtures of two spin-configurations of diquark–antidiquark constituents, $|J, J_{12}, J_{34}\rangle = |000\rangle, |011\rangle$, where J is the tetraquark spin, J_{12} the diquark spin, J_{34} the antidiquark spin. The second configuration involving the spin-1 diquark, $|011\rangle$, is found to be an important ingredient in explaining the resonances of our concern in this tetraquark picture. However, the existence of the $|011\rangle$ component requires additional tetraquarks to be found in $J = 1$ and $J = 2$ resonances with the spin configurations, $|J, J_{12}, J_{34}\rangle = |111\rangle$ and $|211\rangle$, respectively.

In this erratum, we point out that our assignment of $a_1^+(1260)$ as a candidate for the $J = 1$ tetraquark with the $|111\rangle$ configuration is incorrect because of the *C-parity* for its corresponding member in $I_z = 0$. Specifically, we would like to demonstrate that the $|111\rangle$ state with $I = 1, I_z = 0$ must have the *C-parity* odd and, in this regard, a relevant candidate for the $|111\rangle$ state should be $b_1^0(1235)$ ($J^{PC} = 1^{+-}$) instead of $a_1^0(1260)$ ($J^{PC} = 1^{++}$). So its charged member ($I = 1, I_z = 1$), which in fact was considered in our paper, must be $b_1^+(1235)$ instead of $a_1^+(1260)$. Nevertheless, since their experimental masses are almost the same, $M[b_1(1235)] = 1229.5$ MeV, $M[a_1(1260)] = 1230$ MeV, our discussion in the paper, which is mostly based on the mass splittings, is unaltered except that $a_1(1260)$ is replaced with $b_1(1235)$. The other tetraquarks with $J = 0$, $J = 2$, with the spin configurations $|000\rangle$, $|011\rangle$, $|211\rangle$, are found to have $C = +$ so their assignments to the physical resonances are not contradictory with their *C-parity*.

To demonstrate that $C|111\rangle = -|111\rangle$ for the isospin member of $I = 1, I_z = 0$, we take the state with $J = 1$ and the spin projection $M = 1$ among three spin states in $|111\rangle$, and we denote this state as $|JM\rangle = |11\rangle$. The same proof can be done for the other spin states, $|JM\rangle = |10\rangle, |1-1\rangle$. The flavor structure of the member $I = 1, I_z = 0$ is $\frac{1}{\sqrt{2}}\left([su][\bar{s}\bar{u}] - [ds][\bar{d}\bar{s}]\right)$. For our purpose, it would be enough to consider one specific combination of the flavor, $[su][\bar{s}\bar{u}]$. If we rewrite the state $|JM\rangle = |11\rangle$ with respect to the spins and their projections of diquark and antidiquark, $|J_{12}M_{12}\rangle_{[su]}|J_{34}M_{34}\rangle_{[\bar{s}\bar{u}]}$, we find

$$|11\rangle = \frac{1}{\sqrt{2}}\left\{|1_{12}1_{12}\rangle_{[su]}|1_{34}0_{34}\rangle_{[\bar{s}\bar{u}]} - |1_{12}0_{12}\rangle_{[su]}|1_{34}1_{34}\rangle_{[\bar{s}\bar{u}]}\right\}. \tag{1}$$

Now it is straightforward to prove that the state above has $C = -$ by applying the charge conjugation [Eq. (2)], exchanging the diquark and antidiquark parts [Eq. (3)], and renaming the dummy indices $12 \leftrightarrow 34$ [Eq. (4)], i.e.,

$$\begin{aligned}
C|11\rangle &= \frac{1}{\sqrt{2}}\left\{|1_{12}1_{12}\rangle_{[\bar{s}\bar{u}]}|1_{34}0_{34}\rangle_{[su]} - |1_{12}0_{12}\rangle_{[\bar{s}\bar{u}]}|1_{34}1_{34}\rangle_{[su]}\right\} &(2)\\
&= \frac{1}{\sqrt{2}}\left\{|1_{34}0_{34}\rangle_{[su]}|1_{12}1_{12}\rangle_{[\bar{s}\bar{u}]} - |1_{34}1_{34}\rangle_{[su]}|1_{12}0_{12}\rangle_{[\bar{s}\bar{u}]}\right\} &(3)\\
&= \frac{1}{\sqrt{2}}\left\{|1_{12}0_{12}\rangle_{[su]}|1_{34}1_{34}\rangle_{[\bar{s}\bar{u}]} - |1_{12}1_{12}\rangle_{[su]}|1_{34}0_{34}\rangle_{[\bar{s}\bar{u}]}\right\} &(4)\\
&= -|11\rangle. &(5)
\end{aligned}$$

The online version of the original article can be found under doi:10.1140/epjc/s10052-017-4736-6.

[a] e-mail: hungchong@kau.ac.kr

Funded by SCOAP^3.