Contribution ID: **484** Type: **not specified**

Coupled channel description for X(3872) and other XYZ mesons

Saturday, July 18, 2009 11:55 AM (20 minutes)

In the last years a number of exciting discoveries of new hadron states have
challenged our description of the hadron spectroscopy. Among the several charmonium states (X(3940), Y(3940), Z(3930)) the most
mysterious one is the well established $X(3872)$. It was first discovered by
the Belle Collaboration in the $J/\psi\pi\pi$ invariant mass spectrum of the
decay $B \to K^+\pi^+\pi^- J/\psi$. Its mass and relative decay rates outlines a puzzling structure. The $\gamma J/\psi$ and $\gamma\psi'$
decay rates suggest a $c\bar{c}$ structure whereas the ratio $X(3872) \to \pi^+\pi^-\pi^0 J/\psi$ to $X(3872) \to \pi^+\pi^- J/\psi$
which is almost 1 indicates a large
isospin violation incompatible with a traditional charmonium assumption.
On the other hand the $X(3872)$ mass is difficult to reproduce by the standard quark models. The state appears to be too heavy for a $1D$ charmonium state and too light for a $2P$ charmonium one.

In this work, we have performed a coupled channel calculation of the
1^{++} sector including both $c\bar{c}$ and DD^*
states. The calculation was done in the framework of the constituent quark
model of Ref. [1]. Two and four quark configurations
are coupled using the $^3P_0$ model.

All the parameters are taken from the previous calculation in the $c\bar{c}$
sector including the γ parameter of the $^3P_0$ model [2],
so the calculation is parameter free.

We first perform an isospin symmetric calculation including $^3S_1$ and
$^3D_1$ DD^* partial waves.
If we neglect the coupling to $c\bar{c}$ states we don't get a
bound state for the DD^* molecule in the 1^{++} channel,
neither in the $I = 0$ nor in the $I = 1$ channels. When the coupling to $c\bar{c}$ states is included
we find an almost pure $c\bar{c}(1^3P_1)$ state with mass $3467\,MeV$
which we identify with the $\chi_{c_1}(1P)$ and two states with
significant molecular admixture. One of them with mass $3865\,MeV$ is
almost a DD^* molecule bound by the coupling to the $c\bar{c}$ states.
The second one, with mass $3936\,MeV$, is a $c\bar{c}(2^3P_1)$ with
sizable DD^* component. We assign the first state to the $X(3872)$,
being the second one a candidate to the $X(3940)$.

When the mass difference between neutral and
charged states is included a large D^0D^{*0} component is found which dominates
for large distances and breaks isospin symmetry in the physical state.

If we extend the same model to other XYZ charmonium states we get a 2^{++} at M=3968 MeV which can be identified with the Z(3930), but we do not find any candidate for the Y(3940).

As a summary, we have shown that the $X(3872)$ emerges in a constituent
quark model calculation as a mixed state of a DD^* molecule and
$\chi_{c_1}(2P)$ state.
This framework may explain simultaneously the isospin violation
showed by the experimental data and the radiative decay rates.
We interpret
the $X(3940)$ as the $\chi_{c_1}(2P)$ state with a significant
DD^* component. Within the same model the Z(3930) appears as a 2^{++} charmonium state.

[1] J. Vijande, F. Fern\'andez, and A. Valcarce,
J. Phys G {\bf 31}, 481 (2005).
[2] J. Segovia, A.M. Yasser, D. R. Entem, F. Fernandez
Phys. Rev. D {\bf 78}, 114033 (2008).

Primary author: Prof. FERNANDEZ, Francisco (University of Salamanca)

Co-authors: Mr SEGOVIA, Jorge (University of Salamanca); Mr ORTEGA, Pablo G. (University of Salamanca)

Presenter: Mr ORTEGA, Pablo G. (University of Salamanca)

Session Classification: VI. QCD in Hadronic Physics

Track Classification: QCD in hadronic physics